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A TYPHOID FEVER EPIDEMIC CAUSED BY OYSTER-BORNE INFECTION (1924-25)

BY

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INTRODUCTION

About December 5, 1924, an excessive prevalence of typhoid fever in Chicago, Ill., was recognized by the health department of that city. A few days later it was noted that the reports of cases indicated an excessive prevalence also in New York City, Washington, D. C., and several other cities.

The outbreaks in the different cities presented a number of similar general features. Persons of wealth or associated with wealth seemed especially affected. Many persons of prominence were stricken. Such outbreaks, naturally, aroused widespread interest and were given extensive newspaper publicity.

From the studies made by the city health departments of Chicago and New York at the beginning of the period of excess reporting rate, it became apparent that a large majority of the cases in each of those cities was in persons who within the three or four weeks preceding onset of their illness had eaten raw oysters; and that besides oysters no common factor likely to be operative in the spread of typhoid infection was in evidence.

On December 9, the health commissioner of Chicago issued, through the local press and by radio, a warning to the people of that city to refrain from eating raw oysters. On December 17, the health commissioner of New York City placed an embargo upon the oyster beds in lower New York Bay, including Raritan Bay, Princess Bay, and Sandy Hook Bay, and in a letter dated December 19, recommended to the Surgeon General of the United States Public Health Service that steps be taken to prevent the shipment in interstate traffic of oysters dredged from those waters.

Assistant Sanitary Engineer E. C. Sullivan, of the Public Health Service, had been in touch with the situation in New York City from the first recognition of the outbreak and had kept the bureau informed of developments from day to day. The Surgeon General detailed Surg. F. A. Carmelia on December 18, to proceed to New York to inspect oyster beds under suspicion of being polluted.

The aroused popular apprehension about the safety of oysters for food caused a very marked reduction in the oyster trade, the reduction as estimated ranging from 25 to 75 per cent for different producing areas in general, and being almost 100 per cent for the lower New York Bay area. The financial loss to the oyster industry was large and the suffering resulting from deprivation of wages among the thousands of persons dependent upon this industry for

work was serious. The popular apprehension affected not only the shellfish industry but, remarkably, also the scalefish industry.

The Surgeon General decided to have a thorough and comprehensive epidemiological study made of the whole situation. It was obviously important for the investigation to be conducted rapidly, so that definite conclusions as to the cause or causes of the epidemic might be reached and specified as soon as possible.

Surg. L. L. Lumsden was detailed to have general charge of the field studies. The intensive epidemiological work of the Public Health Service was begun in New York City on the morning of January 5, 1925. Surg. H. E. Hasseltine had immediate charge of the study in New York City and vicinity, and detailed to work with him were Surgs. F. A. Carmelia and C. Armstrong, Acting Asst. Surg. C. B. De Forest, and Asst. Sanitary Engineer E. C. Sullivan.

The intensive studies in Chicago and Washington were begun on January 12. Asst. Surg. M. V. Veldee had immediate charge of the study in the Chicago district and had detailed to work with him Sanitary Engineer H. R. Crohurst and Associate Sanitary Engineer Joel I. Connolly. Sanitary Engineer Crohurst also assisted, for a period of about 10 days, in the study of sanitary conditions in and within the vicinity of Great South Bay, N. Y.

The study in Washington, D. C., for a part of the period was under the immediate direction of Surg. J. P. Leake and for the remainder under the personal direction of Surgeon Lumsden. Assistance in the collection of the data here was obtained from Surgs. W. F. Tanner and Norman Roberts, Passed Asst. Surgs. H. E. Trimble, R. E. Porter, L. A. Fullerton and Asst. Surg. L. B. Byington. The finding of a definite explanation of the localized typhoid infection in the southeast section of Washington is to be credited to the painstaking efforts of Surgeon Roberts.

Surgeon Leake visited and made a hurried study of the typhoid situations in Buffalo, N. Y.; Cincinnati, Ohio; Detroit, Mich.; Grand Rapids, Mich.; New Haven, Conn.; Pittsburgh, Pa.; Pittsfield, Mass.; Providence, R. I.; Rochester, N. Y.; and Scranton, Pa., beginning his round of these cities on January 23.

The period of intensive detailed studies by the United States Public Health Service, including collection of case histories, was from January 5 to February 9, 1925. A preliminary report with definite conclusions was submitted to the Surgeon General on February 10. The detailed evidence referred to in the preliminary report is presented in the six sections of this report.

Section I gives an account of the scope and character of the studies. Sections II, III, IV, and V, respectively, present the findings in Washington, D. C., Chicago, Ill., New York, N. Y., and the 10 other cities. Section VI presents a general discussion and the conclusions.

Our studies were made in cooperation with the State and local health departments immediately concerned with the several situations, and with the Bureaus of Chemistry and of Agricultural Economics of the United States Department of Agriculture.

We are especially indebted for much essential assistance and many courtesies (1) to the health departments of the District of Columbia, of Chicago, Ill., of New York City, and of the 10 other cities in which our studies were made; (2) to the State health departments of Illinois and New York; (3) to the local health officers with jurisdictions within the general vicinities of Chicago and New York City; (4) to the administrative officers and field workers of the United States Department of Agriculture with whom we were associated in the work; (5) to the officials of the several companies producing or marketing shellfish who cooperated by furnishing us with important data about their business; (6) to the many restaurateurs who supplied us with salient data about the character and sources of foods served in their establishments; and (7) to the hundreds of individual citizens canvassed, who, with remarkably few exceptions, were thoroughly and cordially cooperative in making an obviously painstaking effort to furnish accurately and completely the data for the epidemiological case histories upon which must be based to a large extent the findings from studies such as those covered in this report.

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M. V. VELDEE, *Asst. Surgeon.*

UNITED STATES PUBLIC HEALTH SERVICE,
Washington, D. C., March 12, 1925.

A TYPHOID FEVER EPIDEMIC CAUSED BY OYSTER-BORNE INFECTION

Section I

STUDIES OF THE EPIDEMIC

The weekly morbidity reports from State and local health departments to the Bureau of the Public Health Service were of great practical value at the beginning and throughout the course of the studies, as they served to indicate the extent of the epidemic and its intensity in different places.

EXTENT OF EPIDEMIC

Table No. 1 presents the number of cases of typhoid fever in 67 cities, with population of 100,000 or over, from which regular morbidity reports are received, as reported by weeks, within the period October 1, 1924, to February 14, 1925, and within each of the two previous corresponding periods.

TABLE NO. 1.—*Cases of typhoid fever, in cities of 100,000 population or over, reported to the United States Public Health Service by city health departments, by weeks, from October 1, 1924, to February 15, 1925, and for corresponding weeks in two preceding years.*

State, city, and population (census of 1920)	October				November					December				January					February	
	4	11	18	25	1	8	15	22	29	6	13	20	27	3	10	17	24	31	7	14
Alabama—Birmingham (178,806):																				
1922–23	2	1	2	1	1	0	1	0	3	1	3	0	0	2	1	0	1	1	0	2
1923–24	4	1	0	0	0	3	3	0	0	1	0	3	0	0	0	0	3	1	1	0
1924–25	7	4	6	4	3	0	1	5	2	4	0	1	1	3	1	0	0	2	0	2
California:																				
Los Angeles (576,673)—																				
1922–23	4	5	7	4	4	2	3	3	4	3	7	3	0	1	2	3	1	1	3	1
1923–24	7	7	7	4	3	5	1	11	6	6	2	7	2	2	1	1	1	4	9	4
1924–25	3	3	4	1	3	2	4	9	2	2	5	---	3	0	2	1	2	0	1	2
Oakland (216,261)—																				
1922–23	0	0	1	1	0	1	1	0	2	0	0	0	1	0	2	0	0	0	0	0
1923–24	1	1	1	0	1	0	0	0	1	0	0	1	1	0	1	0	0	1	0	0
1924–25	2	0	1	0	0	2	0	0	1	0	1	1	1	0	0	1	0	0	1	1
San Francisco (506,676)—																				
1922–23	3	2	2	3	2	5	3	0	0	1	0	3	1	1	0	1	0	1	0	0
1923–24	2	1	2	1	0	2	1	1	0	1	2	5	0	0	1	0	0	0	0	1
1924–25	0	1	1	1	1	1	0	2	1	3	1	1	1	0	4	1	2	0	1	1
Colorado—Denver (256,491):																				
1922–23	4	3	2	9	1	3	2	0	0	0	1	0	0	0	0	0	0	0	0	0
1923–24	8	2	1	2	0	1	0	2	1	0	0	0	0	0	0	0	0	0	0	0
1924–25	2	2	2	0	1	0	2	0	0	0	1	0	0	0	0	0	0	0	0	1
Connecticut:																				
Bridgeport (143,555)—																				
1922–23	0	0	4	1	0	1	1	0	1	0	0	0	0	0	0	1	0	0	0	0
1923–24	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1924–25	1	2	0	2	0	0	0	0	1	0	0	2	2	0	1	0	0	0	0	1

TABLE NO. 1.—*Cases of typhoid fever, in cities of 100,000 population or over, reported to the United States Public Health Service by city health departments, by weeks, from October 1, 1924, to February 15, 1925, and for corresponding weeks in two preceding years*—Continued.

State, city, and population (census of 1920)	October				November					December				January					February	
	4	11	18	25	1	8	15	22	29	6	13	20	27	3	10	17	24	31	7	14
Connecticut—Continued.																				
Hartford (138,036)—																				
1922–23	2	1	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
1923–24	2	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
1924–25	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
New Haven (162,537)—																				
1922–23	3	6	2	2	1	0	0	0	1	1	2	0	0	0	0	0	2	0	0	0
1923–24	8	1	2	0	1	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0
1924–25	1	1	1	1	0	0	1	0	1	2	1	2	0	0	1	0	0	0	1	1
Delaware—Wilmington (110,168):																				
1922–23	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1923–24	---	---	---	---	---	3	2	0	2	3	0	3	0	0	0	0	1	1	0	0
1924–25	0	0	1	2	0	0	1	1	0	1	0	0	2	0	0	---	---	0	---	---
District of Columbia—Washington (437,571):																				
1922–23	6	7	2	4	2	1	5	2	0	1	0	1	4	3	0	1	0	1	1	2
1923–24	1	6	1	2	5	2	1	3	5	1	1	1	0	3	1	1	1	0	0	0
1924–25	0	3	3	5	5	1	0	3	3	10	12	6	5	9	15	6	1	2	1	4
Georgia—Atlanta (200,616):																				
1922–23	2	1	0	1	0	0	0	0	1	0	0	2	0	0	0	0	1	0	0	0
1923–24	3	1	2	1	1	0	3	1	1	0	0	0	0	0	0	0	0	1	0	0
1924–25	0	0	0	3	0	3	2	2	1	2	0	0	0	1	0	0	0	0	0	0
Illinois—Chicago (2,701,705):																				
1922–23	3	3	7	7	6	5	3	2	3	2	1	2	3	3	4	1	3	3	2	0
1923–24	5	7	5	10	11	20	25	38	77	71	41	32	14	20	21	14	16	10	5	8
1924–25	4	6	7	6	6	5	3	3	4	15	21	31	15	27	13	7	10	4	2	2
Indiana—Indianapolis (314,194):																				
1922–23	2	0	1	0	0	0	1	0	1	0	1	0	0	0	1	0	0	0	0	0
1923–24	2	2	0	2	0	1	0	0	2	0	0	0	0	0	2	0	0	0	2	0
1924–25	2	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
Kansas—Kansas City (101,177):																				
1922–23	2	0	1	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0
1923–24	7	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1924–25	4	3	1	0	0	0	0	0	0	0	0	0	0	---	0	0	0	0	0	0
Kentucky—Louisville (234,891):																				
1922–23	2	5	2	5	6	1	2	1	2	1	1	1	0	0	2	0	3	0	2	0
1923–24	5	3	3	1	1	2	0	1	3	0	0	2	0	0	0	0	0	0	0	0
1924–25	7	4	1	6	0	1	3	1	1	3	2	1	3	1	1	0	2	2	0	1
Louisiana—New Orleans (387,219):																				
1922–23	1	4	1	4	4	1	1	6	3	13	2	3	5	3	9	8	5	8	1	2
1923–24	4	3	9	4	5	0	2	0	1	0	1	0	0	1	6	1	2	0	3	2
1924–25	3	4	7	3	2	3	5	2	5	4	9	11	6	2	10	14	4	12	4	4
Maryland—Baltimore (733,826):																				
1922–23	8	10	12	4	3	7	3	6	3	8	3	2	4	2	2	2	2	3	2	0
1923–24	6	5	6	4	4	3	5	7	1	4	2	8	3	1	2	4	1	1	2	1
1924–25	13	4	5	4	2	4	0	2	4	7	2	3	1	5	3	0	1	3	3	1
Massachusetts:																				
Boston (748,060)—																				
1922–23	11	4	4	0	1	2	4	4	3	1	2	0	0	1	0	1	0	0	2	2
1923–24	10	1	4	4	2	1	3	1	1	1	4	4	2	2	0	4	0	4	0	3
1924–25	2	3	2	1	1	1	0	3	2	5	2	1	1	5	1	2	4	0	6	5
Cambridge (109,694)—																				
1922–23	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	1	0
1923–24	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
1924–25	0	0	1	0	0	0	0	1	0	1	1	0	0	0	0	0	0	1	0	0
Fall River (120,485)—																				
1922–23	0	3	0	0	1	2	0	0	0	2	0	0	0	0	0	0	1	1	1	0
1923–24	2	0	1	0	2	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0
1924–25	1	3	---	---	1	1	1	0	0	0	0	0	1	0	0	2	0	0	1	0
Lowell (112,759)—																				
1922–23	1	0	1	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0
1923–24	2	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1924–25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	---	0	0	0	0
New Bedford (121,217)—																				
1922–23	6	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
1923–24	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1924–25	0	0	1	2	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	---
Springfield (129,614)—																				
1922–23	0	1	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0
1923–24	0	0	0	1	1	1	0	0	1	1	1	0	0	0	0	1	0	0	0	0
1924–25	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	2	0	0
Worcester (179,754)—																				
1922–23	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
1923–24	0	1	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0
1924–25	0	1	0	0	0	0	0	0	0	0	---	0	1	2	0	2	0	0	0	0

TABLE No. 1.—*Cases of typhoid fever, in cities of 100,000 population or over, reported to the United States Public Health Service by city health departments, by weeks, from October 1, 1924, to February 15, 1925, and for corresponding weeks in two preceding years*—Continued.

State, city, and population (census of 1920)	October				November					December				January					February	
	4	11	18	25	1	8	15	22	29	6	13	20	27	3	10	17	24	31	7	14
Michigan:																				
Detroit (993,678)—																				
1922–23	7	11	5	6	8	3	0	5	4	2	5	5	2	3	0	0	1	1	4	4
1923–24	5	3	3	1	7	3	1	1	6	7	2	0	1	1	0	0	2	1	1	0
1924–25	7	2	4	0	2	2	3	0	2	0	6	6	8	1	6	7	3	0	4	1
Grand Rapids (137,634)—																				
1922–23	2	0	0	0	0	0	1	0	0	0	0	0	0	2	0	1	1	2	1	1
1923–24	1	0	0	0	0	1	0	1	3	0	0	2	0	1	0	0	0	0	0	0
1924–25	0	0	3	0	0	0	0	4	0	4	5	2	1	1	0	2	2	0	0	0
Minnesota:																				
Minneapolis (380,582)—																				
1922–23	1	0	2	1	1	0	0	0	2	1	1	1	0	0	0	1	0	2	1	3
1923–24	1	2	1	0	0	1	0	1	1	1	0	0	1	1	0	1	2	0	3	0
1924–25	1	4	2	1	0	0	0	1	0	0	3	0	1	2	1	1	2	0	0	0
St. Paul (234,698)—																				
1922–23	2	1	1	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1923–24	1	1	1	1	1	1	0	1	0	3	2	0	0	0	0	1	0	2	1	1
1924–25	0	0	1	0	0	0	0	1	0	1	0	1	0	0	0	0	0	2	0	1
Missouri:																				
Kansas City (324,410)—																				
1922–23	3	3	0	1	0	0	0	1	2	2	0	0	0	0	0	0	0	1	1	0
1923–24	5	2	3	1	0	0	1	0	0	0	0	1	0	0	0	0	0	2	0	0
1924–25	1	6	2	0	1	2	2	1	0	0	1	2	0	0	0	0	0	0	0	4
St. Louis (772,897)—																				
1922–23	6	10	3	5	5	2	4	1	2	8	2	0	2	1	5	0	2	0	0	0
1923–24	5	8	0	2	0	6	3	2	3	4	1	2	0	1	1	1	0	0	2	0
1924–25	4	1	5	3	6	3	0	2	1	3	1	3	6	0	2	2	0	4	0	0
Nebraska—Omaha (191,601):																				
1922–23	0	1	0	0	0	0	0	1	0	1	3	0	0	0	1	0	0	1	2	1
1923–24	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
1924–25	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0
New Jersey:																				
Camden (116,309)—																				
1922–23																				
1923–24	3	2	1	3	0	0	1	0	0	1	2	0	1	0	1	0	0	0	0	2
1924–25	1	3	0	0	2	2	1	0	0	0	0	1	0	0	0	1	0	0	0	0
Jersey City (298,103)—																				
1922–23	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
1923–24	1	1	1	2	0	2	1	0	0	0	1	1	0	1	0	0	0	0	0	0
1924–25	0	1	0	1	0	0	1	1	1	2	0	5	0	3	6	1	0	1	0	1
Newark (414,524)—																				
1922–23	8	16	10	9	8	5	7	0	0	0	3	3	2	1	1	3	3	4	2	0
1923–24	2	0	3	3	1	3	2	1	1	1	1	2	1	0	0	1	1	2	0	1
1924–25	1	1	0	2	0	0	0	4	8	4	1	4	2	1	0	0	1	---	1	0
Paterson (135,875)—																				
1922–23	3	1	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
1923–24	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
1924–25	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Trenton (119,289)—																				
1922–23	2	0	0	1	0	1	0	0	0	1	0	0	0	0	0	1	0	1	1	0
1923–24	0	1	2	1	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0
1924–25	0	0	1	0	1	1	0	0	0	1	0	0	2	0	0	1	0	0	0	0
New York:																				
Albany (113,344)—																				
1922–23	2	0	2	1	1	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0
1923–24	4	0	4	5	1	2	0	0	0	0	1	0	0	4	1	0	0	0	1	---
1924–25	3	0	4	---	0	0	1	1	1	0	---	---	---	---	---	0	0	1	1	1
Buffalo (506,775)—																				
1922–23	0	1	5	4	0	3	0	0	0	2	0	0	0	1	0	1	0	1	1	1
1923–24	1	7	4	1	1	0	0	2	2	0	0	1	0	1	0	1	0	0	3	1
1924–25	2	2	2	0	0	1	2	2	1	1	6	2	3	4	5	0	3	7	1	0
New York (5,620,048)—																				
1922–23	33	25	25	20	13	28	24	25	16	19	19	9	18	14	14	14	8	13	7	7
1923–24	34	21	32	19	16	17	15	18	10	18	20	7	6	4	21	21	9	11	16	7
1924–25	32	14	31	20	20	10	21	32	72	127	109	168	96	99	66	34	25	26	20	8
Rochester (295,750)—																				
1922–23	3	1	1	3	1	1	0	0	0	0	2	2	1	0	1	0	0	1	0	1
1923–24	2	0	0	0	0	0	0	3	3	1	1	0	0	0	0	0	2	0	1	1
1924–25	1	0	0	1	0	1	0	0	1	1	6	9	3	1	3	1	0	0	1	1
Syracuse (171,717)—																				
1922–23	1	1	2	1	0	0	1	0	1	0	0	0	2	0	1	0	1	0	0	0
1923–24	3	0	0	2	0	0	0	1	1	0	0	0	2	0	2	5	2	6	1	2
1924–25	1	1	2	0	0	0	0	0	0	2	0	1	0	2	0	1	1	0	0	0

TABLE NO. 1.—*Cases of typhoid fever, in cities of 100,000 population or over, reported to the United States Public Health Service by city health departments, by weeks, from October 1, 1924, to February 15, 1925, and for corresponding weeks in two preceding years*—Continued.

State, city, and population (census of 1920)	October				November					December				January					February	
	4	11	18	25	1	8	15	22	29	6	13	20	27	3	10	17	24	31	7	14
New York—Continued.																				
Yonkers (100,176)—																				
1922–23	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
1923–24	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	0
1924–25	0	0	0	0	0	0	0	0	0	0	1	---	1	3	12	4	1	4	0	1
Ohio:																				
Akron (208,435)—																				
1922–23	3	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0
1923–24	0	0	0	0	0	0	0	0	0	0	0	---	0	0	0	0	0	1	0	0
1924–25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
Cincinnati (401,247)—																				
1922–23	4	1	1	0	2	0	1	0	0	2	0	1	1	0	0	0	1	0	1	2
1923–24	1	0	2	0	2	0	1	2	0	1	0	0	0	0	1	0	0	0	0	0
1924–25	2	0	0	0	0	2	2	0	1	6	6	1	0	3	6	9	0	4	0	3
Cleveland (796,841)—																				
1922–23	7	4	7	4	1	0	5	5	1	3	6	0	0	5	2	2	1	0	1	0
1923–24	0	1	0	2	1	1	2	0	0	2	2	0	2	3	1	2	0	1	0	4
1924–25	6	1	0	2	0	2	1	2	1	2	2	0	3	3	2	4	0	4	3	2
Columbus (237,031)—																				
1922–23	1	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0
1923–24	0	2	1	4	0	1	0	0	1	0	0	0	0	0	0	0	0	2	0	2
1924–25	1	0	0	0	1	1	1	1	0	0	1	0	0	1	2	0	0	1	1	0
Dayton (152,559)—																				
1922–23	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
1923–24	1	0	2	1	0	---	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1924–25	2	0	2	3	1	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0
Toledo (243,164)—																				
1922–23	3	0	0	0	0	0	6	0	1	---	2	0	0	0	0	0	1	0	0	0
1923–24	1	1	1	0	0	1	1	1	0	0	1	1	2	0	0	0	0	1	0	0
1924–25	3	4	0	3	1	3	0	0	1	1	1	4	3	1	---	0	1	1	0	0
Youngstown (132,358)—																				
1922–23	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
1923–24	0	0	0	0	1	0	0	1	0	0	0	0	0	---	0	0	0	0	0	0
1924–25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oregon—Portland (258,288):																				
1922–23	3	8	5	2	4	3	5	0	1	0	0	0	0	1	0	0	0	0	0	0
1923–24	2	3	0	0	1	1	0	0	3	0	1	0	0	0	0	2	---	0	0	1
1924–25	1	2	4	2	2	1	1	1	0	1	1	1	---	0	1	0	0	0	1	2
Pennsylvania:																				
Philadelphia (1,823,779)—																				
1922–23	14	17	11	5	7	10	6	5	4	8	3	0	5	5	5	1	2	0	1	3
1923–24	10	12	19	14	6	8	4	2	3	4	7	1	2	4	3	1	5	5	3	7
1924–25	27	17	9	15	11	8	6	7	7	1	9	8	4	5	18	2	6	2	3	2
Pittsburgh (588,343)—																				
1922–23	2	4	9	4	0	1	0	0	0	2	1	1	0	3	2	0	1	0	0	1
1923–24	2	1	3	2	2	2	2	0	1	1	0	0	1	2	1	1	1	1	0	2
1924–25	2	2	1	2	1	0	3	1	1	3	3	6	3	3	5	1	3	1	0	1
Reading (107,784)—																				
1922–23	2	0	0	1	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
1923–24	0	2	0	0	1	0	0	0	0	0	0	4	0	0	1	0	1	1	0	0
1924–25	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Scranton (137,783)—																				
1922–23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1923–24	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0
1924–25	1	1	5	---	1	1	1	1	0	1	0	6	3	4	1	2	0	0	0	0
Rhode Island—Providence (237,595):																				
1922–23	2	0	1	1	0	3	0	2	2	0	1	0	1	0	0	0	1	0	0	0
1923–24	0	1	2	0	0	0	0	0	0	1	0	0	0	0	0	3	0	0	0	0
1924–25	4	2	0	2	2	1	1	0	3	3	1	4	0	2	1	3	3	0	0	0
Tennessee:																				
Memphis (162,351)—																				
1922–23	0	1	2	2	3	1	4	1	1	2	1	0	1	1	0	1	0	0	0	0
1923–24	5	11	4	2	1	6	3	0	1	1	1	0	0	1	0	1	5	0	1	1
1924–25	14	7	3	7	1	9	11	8	12	1	8	6	2	3	6	1	0	0	1	4
Nashville (118,342)—																				
1922–23	3	3	0	2	4	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
1923–24	0	2	3	1	3	0	0	0	0	0	0	0	0	4	0	1	0	0	0	0
1924–25	0	2	1	4	6	2	3	0	3	1	0	0	0	0	0	0	2	0	1	0

TABLE NO. 1.—*Cases of typhoid fever, in cities of 100,000 population or over, reported to the United States Public Health Service by city health departments, by weeks, from October 1, 1924, to February 15, 1925, and for corresponding weeks in two preceding years*—Continued.

State, city, and population (census of 1920)	October				November					December				January					February	
	4	11	18	25	1	8	15	22	29	6	13	20	27	3	10	17	24	31	7	14
Texas:																				
Dallas (158,976)—																				
1922–23	2	1	1	2	0	0	0	0	0	2	0	1	1	1	0	0	0	0	0	0
1923–24	0	3	2	0	0	6	12	21	4	0	3	6	1	3	1	1	0	0	3	1
1924–25	1	3	3	0	---	0	0	1	0	0	0	0	0	1	1	0	2	0	0	0
Fort Worth (106,482)—																				
1922–23	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1923–24	0	0	0	0	1	3	1	2	3	0	0	0	0	0	0	0	0	1	0	0
1924–25	1	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Houston (138,276)—																				
1922–23	2	1	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1
1923–24	0	1	2	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	3	0
1924–25	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
San Antonio (161,379)—																				
1922–23	---	---	---	---	---	---	---	---	---	---	1	2	0	0	0	0	0	2	1	0
1923–24	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	2	1	1	0
1924–25	0	0	0	0	0	0	0	2	0	2	0	0	0	1	2	0	0	0	0	2
Utah—Salt Lake City (118,110):																				
1922–23	6	3	4	0	1	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0
1923–24	0	2	3	2	0	1	0	1	0	1	0	0	0	0	1	0	0	1	0	1
1924–25	14	55	19	8	4	8	3	0	1	1	1	1	0	0	0	0	0	0	0	0
Virginia:																				
Norfolk (115,777)—																				
1922–23	0	0	1	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
1923–24	0	0	2	2	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
1924–25	0	1	0	0	0	0	0	0	0	---	0	0	0	0	0	0	0	0	0	0
Richmond (171,667)—																				
1922–23	1	4	1	1	0	0	0	0	0	0	0	2	0	3	1	0	0	0	0	0
1923–24	1	1	2	0	0	0	0	0	2	1	2	1	1	0	0	0	0	0	0	0
1924–25	0	5	0	0	0	7	0	2	3	1	0	2	0	0	0	0	0	1	0	1
Washington:																				
Seattle (315,312)—																				
1922–23	3	0	1	2	0	2	2	3	3	0	1	1	1	3	0	1	1	0	0	0
1923–24	3	4	3	0	1	2	0	1	1	0	0	0	2	0	2	0	1	2	0	1
1924–25	2	3	1	1	2	1	0	1	1	0	0	0	1	1	3	0	---	0	1	0
Spokane (104,437)—																				
1922–23	5	1	0	4	0	3	0	0	0	1	2	0	1	4	0	1	0	0	0	0
1923–24	0	2	3	3	0	1	1	1	0	---	0	0	0	0	0	0	0	---	0	0
1924–25	2	0	1	1	4	1	1	3	2	2	0	2	0	0	0	0	---	0	0	0
Wisconsin—Milwaukee (457,147):																				
1922–23	0	1	3	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	1
1923–24	2	0	0	1	1	1	0	2	1	1	0	1	1	1	0	0	0	0	0	0
1924–25	1	1	0	0	0	0	1	0	1	1	0	1	2	0	1	1	0	0	0	0

These statistics indicate that within the period November 16, 1924, to January 17, 1925, the number of cases reported for these 67 cities was such as to evidence (1) definite outbreaks of typhoid fever in three of the cities—Washington, D. C., Chicago, Ill., and New York City; (2) a markedly excessive prevalence in 10—Buffalo, N. Y., Cincinnati, Ohio, Grand Rapids, Mich., Jersey City, N. J., Memphis, Tenn., Pittsburgh, Pa., Providence, R. I., Rochester, N. Y., Scranton, Pa., Yonkers, N. Y.; (3) a slightly excessive prevalence in 11—Birmingham, Ala., Boston, Mass., Bridgeport, Conn., Detroit, Mich., Louisville, Ky., Newark, N. J., New Haven, Conn., New Orleans, La., Philadelphia, Pa., San Francisco, Calif., and Toledo, Ohio; and (4) no excessive prevalence in 43.

By markedly excessive prevalence is meant that the number of cases reported for the city for the 1924–25 period was in excess by

more than 10 cases and totaled over three times as many for this period as for the mean of the 1923–24 and the 1922–23 periods. By slightly excessive prevalence is meant that the number of cases reported for the 1924–25 period exceeded by at least five cases that of the mean of the two previous periods.

From these records it is apparent that the excessive prevalence of typhoid fever was of such extent and degree during November and December, 1924, as to be properly designated an "epidemic." If complete morbidity statistics were available for all cities, towns, and rural districts that were stricken, the epidemic proportion might be stated with an approach to exactness. From such reports as are at hand, it is estimated that within the period of the epidemic there were over 1,500 cases of, and 150 deaths from, typhoid fever in excess of the normal expectancy for such period.

PERIOD OF CAUSATION

The interval elapsing between the definite onset of the attack of fever and the date of the report of the case to the local health department was about 14 days for the average case. The extreme range of the incubation period (the interval between day of becoming infected and day of going to bed) was probably between 5 and 35 days, and for the average case was, according to such evidence as we have, about 20 days (see p. 54). It is believed that for the large majority of the cases a date set 20 days prior to definite onset of the illness will approximate the day upon which the person stricken ingested the infection. On this basis, it appears that the period of causation of the outbreaks in Washington and Chicago began at very nearly the same time—about October 26—and about seven days subsequent to the beginning of the period of causation in New York City. It appears, also, that the period of causation of the epidemic, considered as a whole, ended by December 20, 1924.

INTERRELATION OF OUTBREAKS

The generally similar features and the chronology of the outbreaks in the different places suggested a common factor in the spread of the infection. Therefore, the data secured from the intensive epidemiological study in each of the cities were compared from time to time in the course of the studies with those found in the other cities with a view to determining to what conditions, if any, the persons infected in the different communities had been exposed in common. Careful consideration was given, however, to the possibility that the outbreaks were merely coincidental in time and not connected by any common causative factor. Each situation was studied as an entity, and an endeavor was made to determine as nearly exactly as possible

the identity and the relative degree of operation of every factor which could have been operative in the spread of the infection in that community.

INTENSITY OF STUDIES

The studies of the outbreaks in Washington, Chicago, and New York were conducted on a scale and with sufficient intensity, it is believed, to collect the salient data, and were continued until the findings led to a definite conclusion as to the principal causative factor or factors in each of these cities.

The studies in the other 10 cities were less intensive and were conducted in the main to ascertain if the situations in those cities were related in causation to those in Washington, Chicago, and New York.

A conclusion as to the degree or the extent of operation of any causative factor was not reached until the evidence collected appeared to make such conclusion inescapable.

SCOPE OF STUDIES

Our epidemiological studies of cases and of many local conditions were made by field forces of the Public Health Service working independently of those of the respective local health departments concerned. By this arrangement, the findings of two separate groups of investigators were made available for comparison. The fact that the findings of the two groups of workers in each of the situations checked substantially in most respects added to their weight of evidence.

The Public Health Service forces obtained, from their direct interviews with persons, reasonably complete epidemiological histories of 41 cases in Washington, D. C.; 100 in the Chicago district; 263 in the New York City district; and 82 in the other 10 cities.

METHOD OF OBTAINING DATA

The interviews in the vast majority of instances were direct with the patient or convalescent. Therefore, the only chance for error in the statements was, as a rule, it is reasonable to assume, in fault of memory. Whenever the person interviewed expressed doubt about the answer to a question on any point, either that point was omitted from the history or the answer was recorded as uncertain.

In obtaining the individual epidemiological histories the following form was used:

[FRONT]

TYPHOID EPIDEMIOLOGICAL RECORD SHEET

Locality ---------- Date investigated----------
Case No. ------ Name ---------- Age ---- Sex ----------
Color -------- Nationality ---------- Date first symptoms ----------
Date took to bed ---------- Where born----------
Present address ---------- From----------
Residence when taken sick ---------- From ---------- to -------
Previous residence ---------- From ---------- to ----------
Temporary absences from city within 30 days (dates, hotels, or other address):

Mode of travel, railroad ---------- Automobile ---------- Steamboat-----
Food and beverages while absent----------

No. in party ---------- Other cases in party----------
No. in household ---------- Ages and sexes----------
No. in household had typhoid with years ----------
Gen. San. cond. of residence ---------- Apparent econ. cond. ---------
Occupation ---------- Place ----------
From ---------- To----------
Other cases or suspects at place of work ----------

PATIENT'S HISTORY

Apparently typical course ---------- Duration of fever ----------
How long in bed ---------- Condition when visited ----------
Onset (character) ----------
Widal---------- When ----------
Blood culture ---------- When ----------
Stools or urine---------- When ----------
Immunization ---------- When ---------- Prev. attack ----------
When ----------

WATER

Solely ---------- Principally ----------
Occasionally ----------
Bottled ---------- Kind ---------- Where ----------
Ice sources ----------

MEALS

Where taken ----------

FOOD

Milk (how used) ---------- Boiled ----------
Past. ----------
Source ----------

[BACK]

Ice cream---------- Where---------- Sources------

Butter---------- Sources----------
Cheese---------- Kind---------- Sources----------
Uncooked vegetables (kinds eaten)----------
At home—let., cel., rad., onions, endive, cab., watercress, romaine, tomatoes.
In restaurants—let., cel., rad., onions, endive, cab., watercress, romaine, tomatoes.
Immediate sources----------
Raw oysters, yes------ no------
Shell---------- Kind---------- Where---------- When----------
Shucked------- Kind---------- Where---------- When----------
Underheated---- Kind---------- Where---------- When----------
Immediate sources shell----------
Immediate sources shucked----------
Immediate sources underheated----------
Clams, yes---------- no---------- Raw---------- Heated----------
Kind---------- Where---------- When----------
Immediate sources----------

PUBLIC DINNERS

Assembly luncheons---------- Assembly dinners----------
Place---------- Date---------- Number present--------
Place---------- Date---------- Number present--------
Place---------- Date---------- Number present--------
Remarks----------

Informant----------
Relation to patient----------

Investigator.

A patient endeavor was made to obtain definite statements, as complete as possible, on all the points indicated in this record sheet. The period inquired into especially with respect to foods and beverages to which the person was exposed was the one of 25 days extending up to the fifth day before the definite onset of the illness. Memory dates, including for many of the cases election day, armistice day, or Thanksgiving Day, in such period, were helpful in this connection.

INTERPRETATION OF EVIDENCE

It is quite possible that a few of the persons interviewed were on the defensive for some possible factor in the spread of the infection, and purposely gave misleading statements about it. It is quite possible also that another few wilfully gave misleading statements in the hope of incriminating that same factor. It seems reasonable to believe that errors resulting from such tactics would about balance in the summation of evidence.

Every condition or factor to which the evidence from the case histories pointed as possibly having been operative to an appreciable extent in the spread of the infection was considered and studied. Water, milk, milk products, vegetables, fruits, shellfish, bread, fingers, and everything else which, it seemed, could possibly have served as a medium in the conveyance of human excreta to the mouths of the persons affected were given careful attention.

With the fundamental knowledge, coming to us from the work of the epidemiologists who have gone before, that typhoid fever infection comes only from human excreta and that the excreta from some persons in apparently good health are as infectious as are those from persons suffering with the disease, we, of this time, have a fair start in the study of the epidemiology of typhoid fever outbreaks.

In the course of our studies of this epidemic, various conceivable factors in the spread of the infection were eliminated one after another, but no one of them was eliminated until the evidence was convincing to us that such factor, according to all scientific criteria and the dictates of common sense, could not have been operative to any considerable extent in the causation of the epidemic.

Section II

THE OUTBREAK IN WASHINGTON, D. C.

Within the period January 1 to December 1, 1924, the number of cases of typhoid fever reported in the District of Columbia was 98 as against 109 in the corresponding period of 1923 and 178 in the corresponding period of 1922. Thus it is apparent that the number of cases of typhoid fever reported here for the first eleven months of 1924 was somewhat below the usual. Early in December the number of cases reported showed a marked increase. The increased reporting rate continued through December and well into the first half of January, 1925. The number of cases reported from December 1, 1924, to January 16, 1925, inclusive, was 63 as against 9 in the corresponding period of 1923–24, and 12 in the corresponding period of 1922–23. Thus, the excess of cases reported within this period of 1924–25 was about 52.

The following tabular statement presents certain general data about the cases reported in the period of the recent outbreak and the cases reported in the two previous corresponding periods:

Cases of typhoid fever reported December 1 to January 16 in the District of Columbia

Years	Total cases reported	Cases reported among non-residents	Cases reported among residents											
			Total	Age			Sex		Race		Section of city in which case occurred			
				0–19	20–34	35 and over	M.	F.	W.	C.	NW.	SW.	NE.	SE.
1922–23	12	2	10	2	3	5	3	7	9	1	5	1	1	3
1923–24	9	1	8	2	3	3	3	5	6	2	6	0	2	0
1924–25	63	14	49	8	27	14	23	26	47	2	33	0	7	9

In the recent outbreak, the proportion of cases was unusually large (1) among white persons, (2) among residents of the northwest section of Washington, and (3) among persons 20–34 years of age.

AGE-SEX DISTRIBUTION

The case rate per 100,000 of population in different age-sex groups, based on the number of cases reported within the period December 1, 1924, to January 16, 1925, and on the census of 1920, was as follows:

Years of age	Case rate	
	Male	Female
0–19	6.6	6.3
20–34	17.5	20.4
35–74	13.04	6.8

Table No. 2 presents the number of cases reported in different age-sex groups among residents of Washington within this period:

TABLE NO. 2.—*Resident cases of typhoid fever reported December 1, 1924, to January 16, 1925*

Ages	Sex		
	Male	Female	Total
0–4	0	1	1
5–9	1	0	1
10–14	1	1	2
15–19	2	2	4
20–24	5	5	10
25–29	4	5	9
30–34	2	6	8
35–39	3	1	4
40–44	2	2	4
45–49	2	0	2
50–54	1	1	2
55–59	0	2	2
Total	23	26	49

The proportion of the cases furnished by children was unusually low. Of the 49 cases only 2 were in persons under 10 years of age, and only 4 were in persons under 15 years of age. The majority of the cases in the group 20–34 years of age was among women. The age-sex distribution of typhoid fever in the recent outbreak was quite different from the usual annual distribution in Washington and also from that which is usual in explosive outbreaks caused by water-borne or milk-borne infection, for instance. Table No. 3 presents the cases of typhoid fever reported among the different age-sex groups resident in the District of Columbia in the first 11 months of 1924 and in the calendar years 1923 and 1922:

TABLE 3.—*Age-sex distribution of typhoid-fever cases reported in the District of Columbia*

Age	1924, Jan. 1-Nov. 30			1923			1922		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
0–4	0	1	1	0	3	3	2	1	3
5–9	5	5	10	5	6	11	3	10	13
10–14	4	2	6	2	5	7	10	11	21
15–19	6	3	9	3	7	10	12	5	17
20–24	5	8	13	5	11	16	14	15	29
25–29	9	3	12	5	4	9	5	11	16
30–34	2	6	8	6	6	12	7	13	20
35–39	4	2	6	2	1	3	7	9	16
40–44	5	0	5	2	3	5	7	2	9
45–49	2	2	4	2	0	2	4	0	4
50–54	2	0	2	2	0	2	5	1	6
55–59	1	2	3	1	0	1	2	0	2
60–64	0	0	0	0	2	2	0	1	1
65–69	0	0	0	1	0	1	1	1	2
70 or over	0	0	0	0	0	0	1	1	2
Not given	0	1	1	1	1	2	3	2	5
Total	45	35	80	37	49	86	83	83	166

In this period of two years and eleven months, children under 15 years of age furnished 21.8 per cent of the cases reported, but in the period December 1, 1924, to January 16, 1925, only 8.16 per cent of the cases reported. In both of these periods, cases among females composed the majority furnished by persons 20–34 years of age. The sex distribution of typhoid fever in Washington in these last three years is strikingly different from what it was 15 or 20 years ago. Among cases of typhoid fever occurring among persons 20–34 years of age in the District of Columbia in the calendar year 1909[1], for example, 150 were furnished by males and only 72 by females—the ratio of cases to number of persons in each group being 1 to 260 for males and 1 to 653 for females.

STUDY OF OUTBREAK

The intensive study of the recent typhoid-fever situation in Washington by the United States Public Health Service was begun on January 12, 1925. The epidemiological investigation of individual cases was confined to the 63 cases reported within the period December 1, 1924, to January 16, 1925. Of these cases, 14 reported from hospitals in Washington were in persons whose residences were recorded outside the District of Columbia—11 in Maryland and 3 in Virginia. As the study here was purposed to determine the main factor or factors in the spread of the infection in Washington, no effort was made to obtain further detailed information about these 14 cases from Maryland and Virginia residences.

Of the 49 cases reported among residents of the District of Columbia, two were found to be in persons who had been living in hotels in New York City for all or almost all of the 30 days immediately preceding onset of illness, and are rated as out-of-Washington infections; eight were in persons who were either dead or removed from Washington before the investigator could reach them to obtain their epidemiological histories; and three were in persons who were thoroughly exposed, under unhygienic conditions for three or four weeks immediately preceding onset of illness, to a previous case of typhoid fever, and were definitely attributed to personal contact infection, and are rated as secondary cases. Of the remaining 36 cases, detailed epidemiological histories were obtained. The interviews were direct with the person affected for almost every case. A persistent effort was made to ascertain every fact which was regarded as likely to throw any possible light upon the source of the infection.

WHERE INFECTION WAS CONTRACTED

Of the 36 primary cases, 27 are recorded as certainly having contracted their infection within the District of Columbia because they

[1] Hygienic Laboratory Bulletin No. 78 (1911), p. 26.

had not been away from Washington within the 30 days immediately before onset of illness, and nine are recorded as very probably having contracted their infection within the District of Columbia because they had been in Washington over three-fourths of the time within the 30 days immediately preceding onset of illness. Of the nine cases in persons who were away from Washington for a small proportion of the time within which, judging by the usual range of the incubation period of typhoid fever, they became infected, all were in

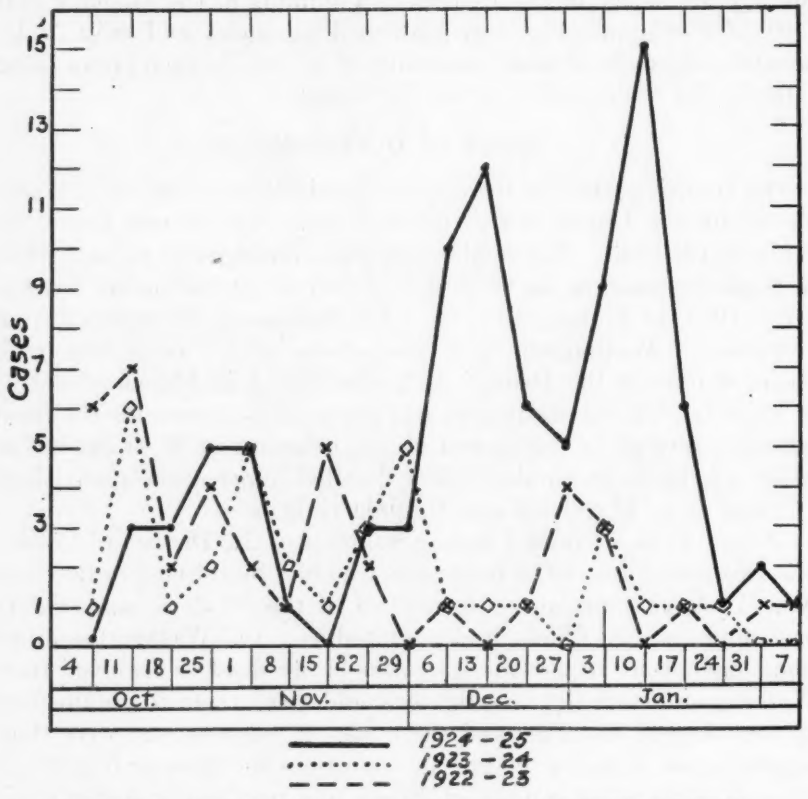


CHART NO. 1.—Cases of typhoid fever reported, by weeks, in the District of Columbia

persons who had eaten within such period at public restaurants of the higher class in other cities—four in New York City; three in Baltimore, Md.; one in Norfolk, Va.; and one in Binghamton, N. Y.

The remainder of this section of this report deals with the 36 primary cases in persons certainly or almost certainly contracting their infection in Washington.

PERIOD OF OUTBREAK

Chart No. 1 presents graphically the report of cases of typhoid fever to the District health department by weeks from October 1 to February 7, 1924–25, 1923–24, and 1922–23. Chart No. 2 shows the

dates of definite onset of the cases whose histories were obtained in detail in the recent study in Washington. The date of definite onset corresponds to that upon which the person affected took to bed or became so ill as to give up usual pursuits entirely. This chart indicates that the period of markedly excessive prevalence, as evidenced by development of cases, was from November 20 to December 29, 1924. The main part of the period of causation of the outbreak is regarded as between November 1 and December 10. It is believed from all knowledge we have of the range of typhoid incubation and from such evidence as we have of the dosage of infection in this instance that over four-fifths of the cases in this outbreak contracted the infection within that part of the possible period of causation.

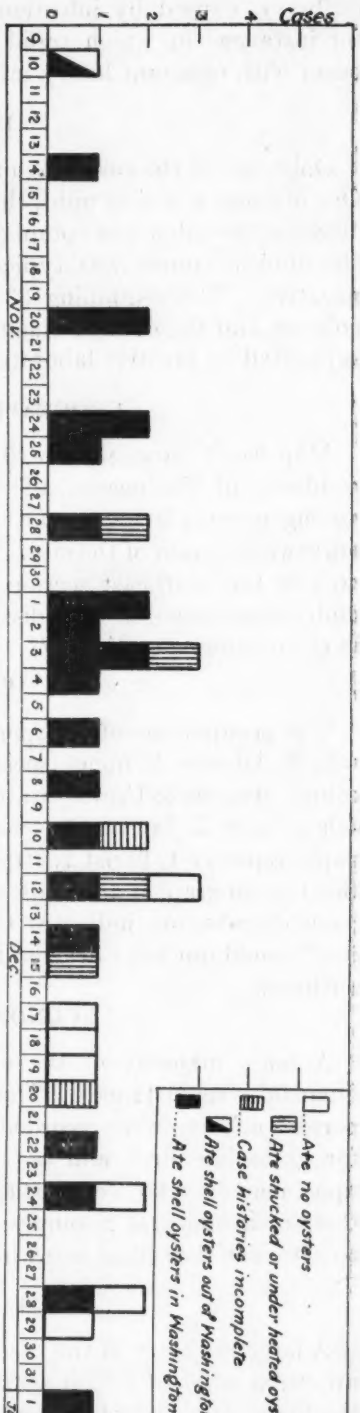


CHART NO. 2.—Dates of definite onset of 36 primary cases of typhoid fever investigated among cases reported in the District of Columbia within the period Nov. 1, 1924, to Jan. 16, 1925

IMMUNIZATION

Five cases gave a history of injection with three doses of typhoid vaccine for protection against typhoid fever—one in 1923, one in 1919, two in 1918, and one in 1912. The two cases injected in 1918 gave a history also of a previous attack of typhoid fever—one in 1907 and one in 1902. This proportion among persons assumed to have some degree of immunization is the only suggestion of heavy dosage infection. Only two of the 36 cases gave a history of sudden onset of definite symptoms, one with acute abdominal pain, and one with a shaking chill. A considerably larger proportion of cases with sudden onset is to be expected in

outbreaks caused by infection conveyed by some medium—as milk, for instance—in which rapid multiplication of typhoid bacilli may occur with resultant heavy infection of persons exposed.

DIAGNOSIS

Only two of the cases gave a history of an atypical clinical course. One of these was very mild, the patient being confined to bed for only 10 days; the other was complicated with pneumonia. In a third case the clinical course was typical but repeated laboratory tests were negative. The remaining 33 cases ran apparently typical clinical courses, and the clinical diagnosis for the large majority of them was supported by positive laboratory findings.

GEOGRAPHIC DISTRIBUTION

Map No. 1 shows the distribution of the cases according to place of residence of the person affected. The majority of the cases was among persons living in the better residential neighborhoods in the northwest section of the city. The group of cases indicated in a small area in the southeast section of the city was among persons living under conditions generally dissimilar from those of the persons affected in the northwest section.

OCCUPATION

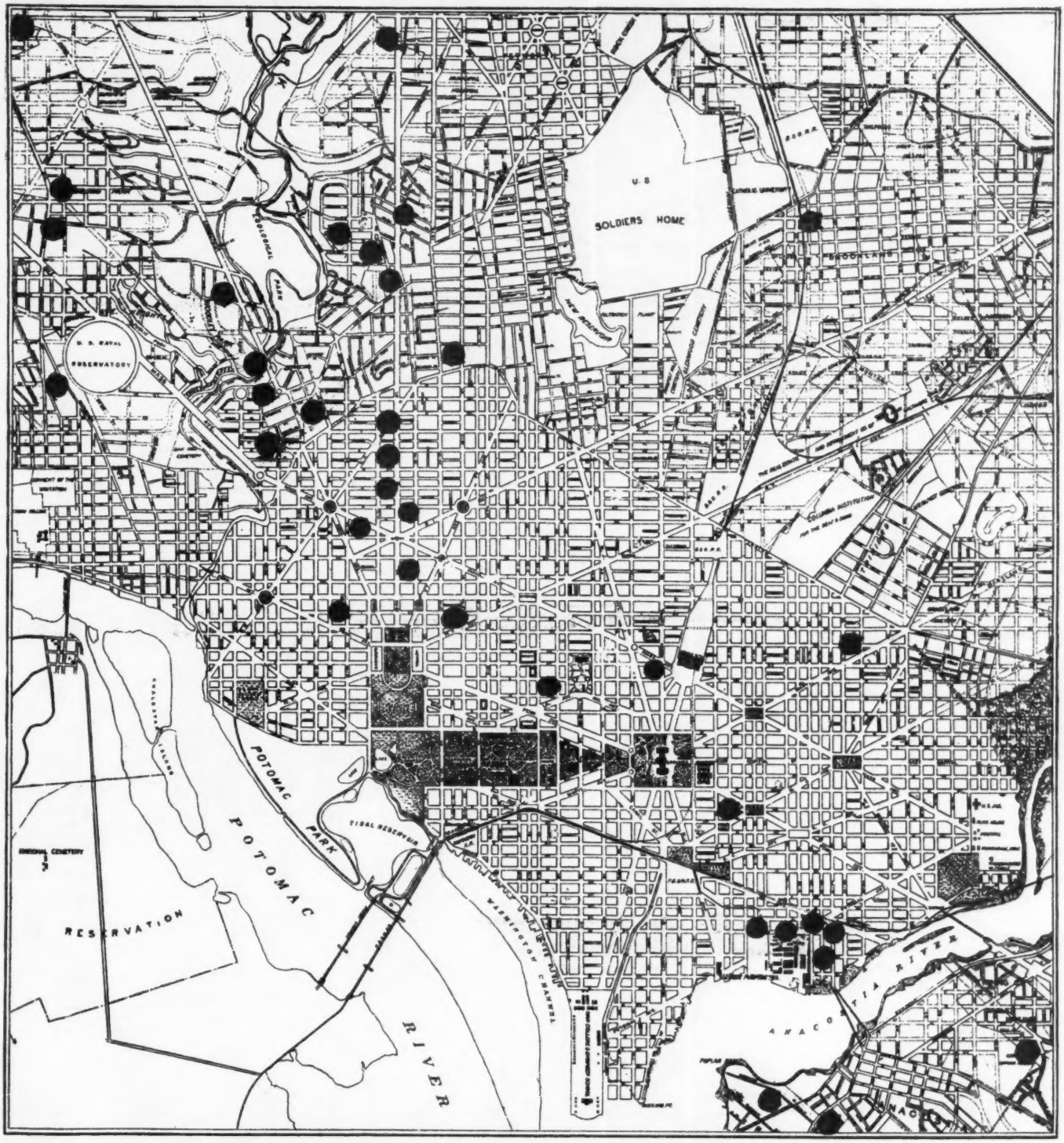
The occupations of the persons affected were as follows: Housewife 6, laborer 4, none (society women) 3, clerk (Government) 3, college student 3, United States Government official 2, school child 2, saleswoman 2, lawyer 2, school teacher 1, foreign official 1, newspaper reporter 1, florist 1, street-car conductor 1, machinist's apprentice 1, stenographer and clerk (business) 1, clergyman 1, and banker 1. Such distribution indicates that occupation of persons affected, in itself, could not have been an important factor in the causation of the outbreak.

ECONOMIC CONDITIONS

A large majority of the cases occurred among persons in good financial circumstances. The apparent economic conditions of the persons affected were recorded as excellent for 13 of the cases, as good for 12, as fair for 6, and as poor for 5. The outbreak fell especially upon persons who were socially active, and who were able through their own financial resources or those of their friends or employers to eat what they liked and where they chose.

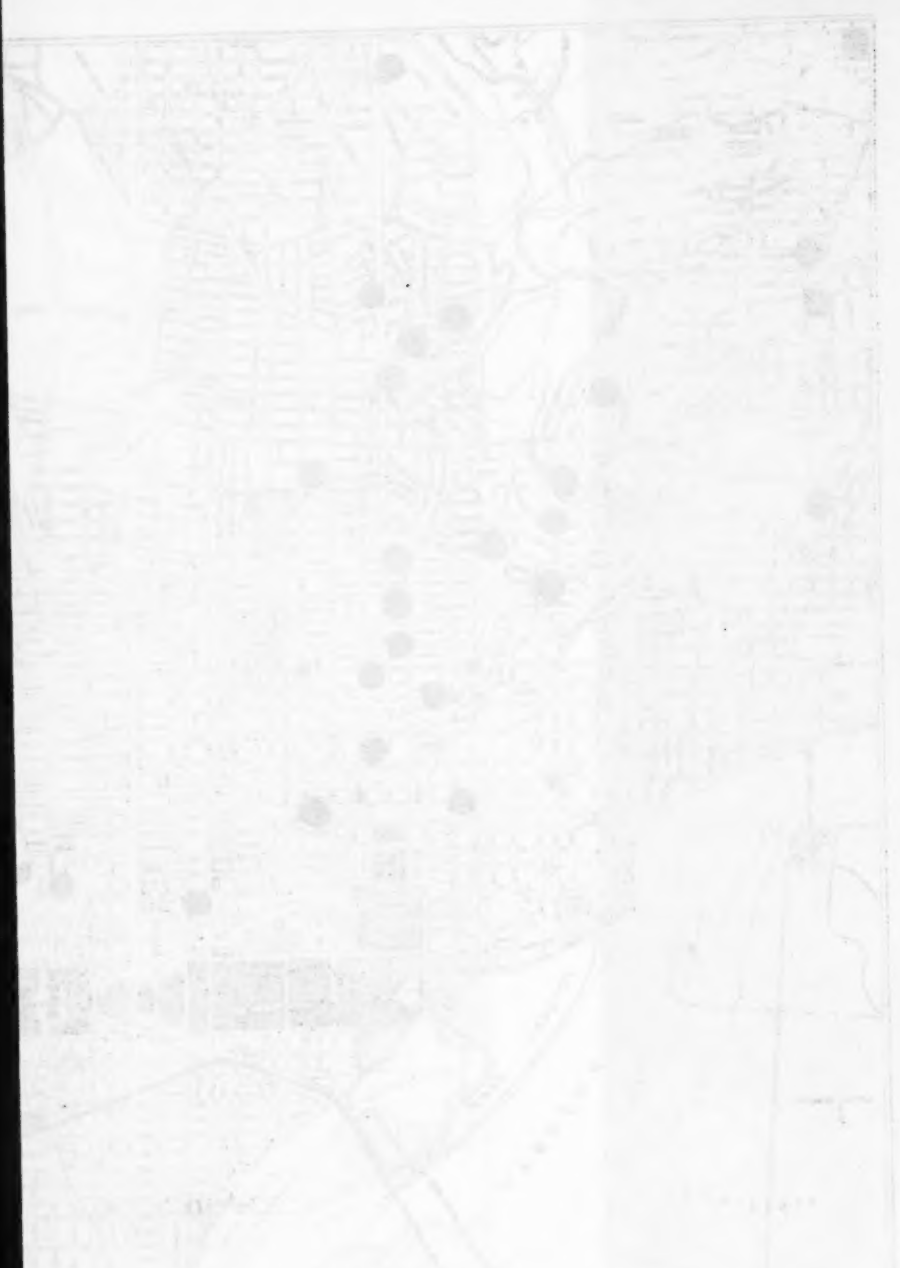
SANITARY CONDITIONS

A large majority of the cases occurred among persons whose homes appeared to be of a high sanitary order. The sanitary conditions of the home were recorded as excellent for 16 of the persons affected, as



MAP NO. 1.—Location of residences at which occurred 36 primary cases investigated in Washington, D. C.

37639—25†. (Face p. 20.)



good for 11, as fair for 5, and as poor for 4. There was nothing to suggest that insanitary home conditions were a factor in the spread of the infection causing the outbreak.

WATER

All of the cases were in persons who used the public water supply of the city as the sole or principal source of water for drinking purposes. Only five of the cases gave a history of exposure to bottled water. The selective distribution of the infection, the record of bacteriological examinations of the water, and all other points of evidence obtained, support the conclusion that water used for drinking did not operate as a considerable factor in the spread of the infection causing the outbreak among residents of the northwest or of the northeast section of Washington.

The evidence is very strong, however, that tap water was the chief factor in the spread of the infection to the group of nine cases occurring among the residents or frequenters of the southeast section of the city. These nine cases were in persons who either worked at or resided in or visited daily the immediate vicinity of an industrial plant located near the Anacostia River, and obtained all or a large proportion of the water they drank within the 30 days prior to onset of their illness from taps either at or nearby this plant. The dates of definite onset of illness in these cases were as follows: One on December 10, two on December 12, one on December 17, one on December 18, one on December 19, one on December 24, one on December 28, and one on December 29. All very probably became infected within a period of a few days—possibly on the same day. About November 25, persons using the tap water in this vicinity, which comprises about seven city blocks, noted that the water was somewhat turbid and offensive to both taste and smell, and the management of the industrial plant reported the condition of the water to the District water department. Within the next 48 hours, diarrheic attacks, typical of so-called "winter cholera," were highly prevalent among the residents of the vicinity. The water department found upon investigation that the most probable explanation of the pollution of the water was inadvertent pumping of raw water from Anacostia River into one of the city water mains. So far as could be ascertained, it seems that an engineer at the industrial plant had opened the valves and made the pipe connection in order to use the city water in place of the raw water from the Anacostia River supply, and that his relief, coming on duty later the same night, without knowing the valves were open, started the pump which had power to overcome the city water pressure and thereby forced the raw Anacostia River water into the city main.

Diagram No. 1, based on data furnished us by the District water department and the management of the industrial plant, shows the

then arrangement of the valves and the mains, and map No. 2 shows the course the polluted water from Anacostia River would have taken in this limited extent of the city water mains. The District water department had changes made at once in the system to preclude the possibility of another such accident.

The epidemiological histories of this group of cases in the southeast section stand out in sharp contrast in many respects to those of the cases in the other sections of the city, and indicate that the principal factor in the spread of the infection to these cases was separate and distinct from that which was principally operative

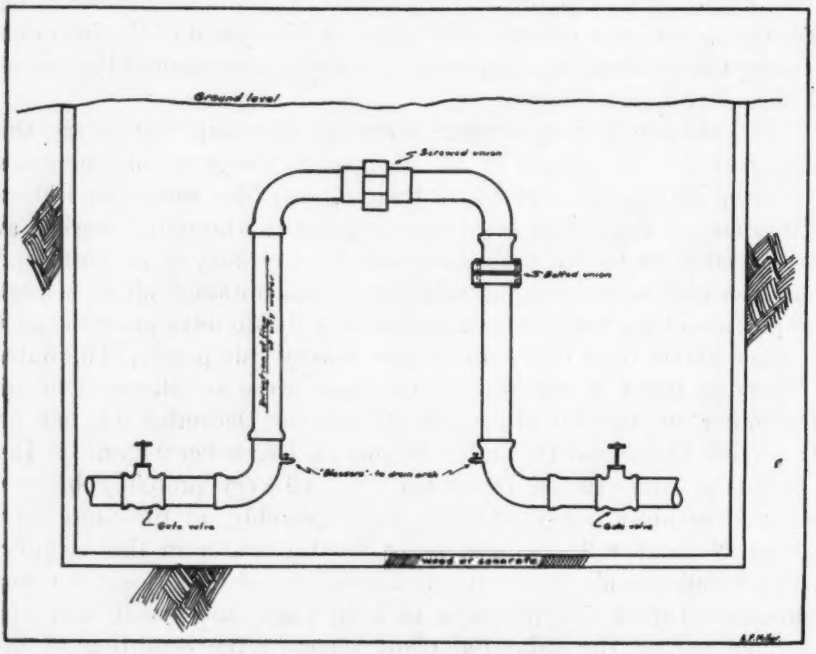


DIAGRAM NO. 1.—Connection between city water supply and polluted water supply from Anacostia River, southeast section of Washington, D. C.

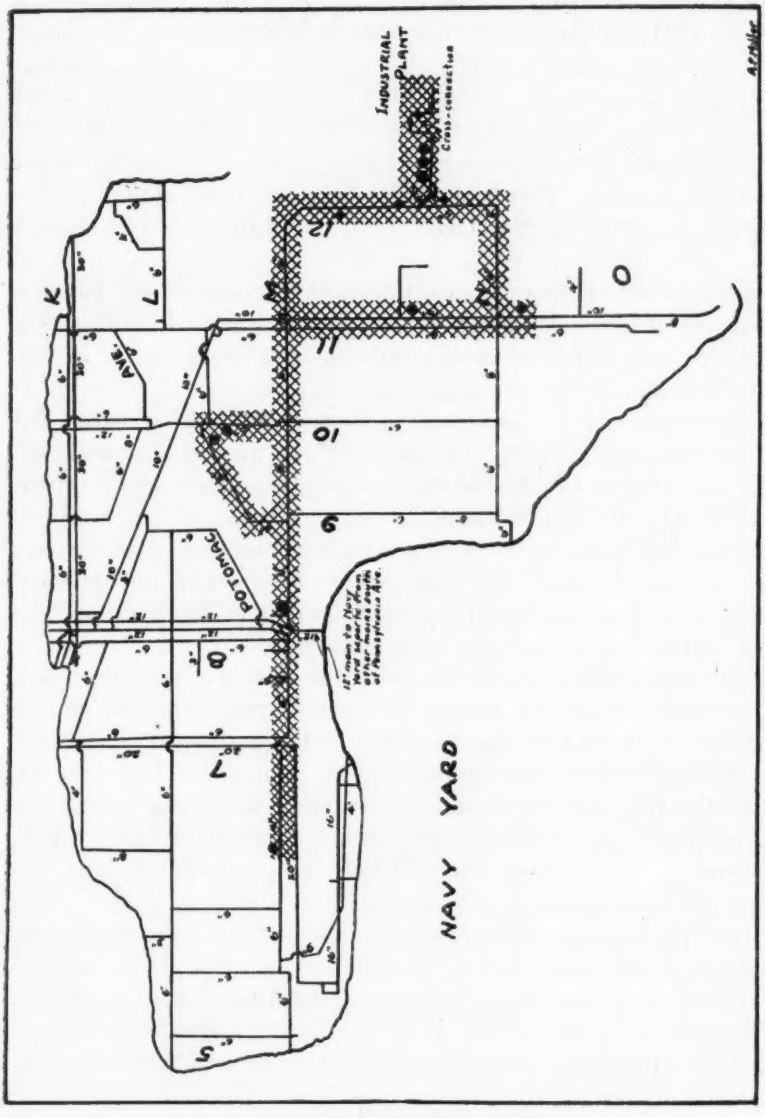
among the persons in the northwest section of the city where the majority of the cases composing the excessive prevalence or outbreak proper occurred.

MEALS, WHERE TAKEN

The history given with respect to places at which meals were taken within the 30 days immediately before onset of illness was as follows: 6 at home or regular boarding place only; 5 at restaurants only; 25 at both home or regular boarding place and one or more restaurants.

Of the 30 who patronized restaurants, 14 gave a history of having eaten within the period at three or more restaurants. The restaurants whose patrons were especially affected are among the best and higher price public eating places in Washington. Most of them are operated in connection with the best hotels or clubs.

The preponderance of cases among frequent diners-out suggested that the main factor in the spread of the infection was some food or beverage served at the public eating places rather than at the private homes.



MAP NO. 2.—Vicinity in southeast section of Washington, D. C., showing course which would be taken by polluted water from Anacostia River introduced into city main at industrial plant
Shaded area indicates approximate extent of distribution. Arrows indicate direction of flow of water in mains
——= Water main
●= Case of typhoid fever in person exposed to water from taps at place indicated

MILK AND MILK PRODUCTS

No evidence was obtained pointing to milk or any milk product as having been a considerable factor in the spread of the infection. The number of cases among the users of milk from the different principal milk supplies of the city was as nearly proportionate to the

amount of the milk distributed as could be expected with such a limited number of cases.

Among the patrons of dairymen Nos. 1, 2, 3, 4, 5, and 6, were, respectively, 11, 4, 3, 2, 2, and 1 cases.

The number of gallons of milk distributed on the average day in November, 1924, by these dairymen was as follows:

No. 1	gallons	13, 500	No. 4	gallons	2, 400
No. 2	do	3, 500	No. 5	do	4, 500
No. 3	do	3, 750	No. 6	do	3, 300

The amount of milk distributed daily by these six dealers totals about 31,000 gallons. The total daily distribution of all the forty-odd dairymen supplying the District of Columbia is about 42,000 gallons.

The histories with respect to how milk was used within the 30 days prior to onset of illness by the persons affected was as follows: As a beverage, 18; with fruits or cereals but not as a beverage, 6; in hot tea or coffee only, 5; and in no way, 7.

Twenty-seven of the cases gave a history of having eaten ice cream, but the supplies were various and there was no apparent disproportionately large number of cases among the eaters of ice cream furnished by any of the producers.

Practically all of the cases gave a history of having eaten butter, but the sources of the butter, also, were various, and no evidence was found of a disproportionately large number of cases among the eaters of butter from any of the many sources.

It is not reasonably conceivable with the data at hand that any supply of milk, cream, ice cream, or butter, distributed as widely as it would have had to be to reach a large proportion of the persons affected, could have operated as an appreciable factor in the spread of the infection without causing many more cases than occurred, especially in children. The small number of cases—both relative and actual—among the children is alone very strong evidence for the elimination of milk and milk products.

Sixteen of the persons affected gave a history of having eaten cheese, 18 of having eaten none, and 2 were uncertain. Six of the persons were exposed to Roquefort, 4 to Swiss, 3 to American, 3 to cream, 2 to Camembert, 1 to Edam, and 1 to Kraft. Evidently cheese could not have been an important factor in the spread of the infection.

RAW VEGETABLES

The history given with respect to the eating of uncooked vegetables within the 30 days immediately before onset of illness was as follows: 21 ate lettuce, 23 ate celery, 5 ate radishes, 5 ate water cress, 4 ate onions, 3 ate tomatoes, 2 ate endive, 1 ate romaine, and 8 ate no raw vegetables of any kind. It appears from these

data that none of these raw vegetables excepting lettuce or celery could have been an important factor in the spread of the infection causing the outbreak. None of the findings pointed to either lettuce or celery as a considerable factor in the spread of the infection.

So far as could be determined under the very complex marketing of such products, the sources of the lettuce and celery eaten by the 36 persons affected were as many and various as those of the lettuce and celery eaten in the same period by the average 36 persons indulging in such food in Washington.

The proportion of cases furnished by persons who ate raw lettuce or raw celery was presumably about the same as the proportion of the general population in comparable economic conditions exposed to the eating of such food in November, 1924 (see pages 29 and 30). If either lettuce or celery had played an important part in conveying the infection, it is difficult to conceive why the proportion of cases in children and in persons in less affluent circumstances than those who developed typhoid fever would not have been very considerably larger than it was.

The elimination of both lettuce and celery from the list of possibly important factors is based on an entire lack of evidence to implicate them, and on the very positive evidence that another factor was the main one in the spread of the infection.

RAW SHELLFISH

Of the 36 cases, 27 were in persons who gave a definite history of having eaten raw or undercooked oysters once or more within the 30 days immediately before onset of their attacks of typhoid fever, 2 were in persons who were uncertain about the eating of such oysters, and 7 in persons who stated definitely that they had not eaten raw or undercooked oysters within such period. Of the 34 cases giving a definite history on this point, 27, or 79.4 per cent, were in persons exposed to the eating of raw or undercooked oysters. Of these, the statements recorded are that 23 ate raw shell oysters, 2 ate raw shucked oysters, and 2 ate undercooked oysters. The undercooking, as described, was such as not to have accomplished more than a luke-warming of the stomach contents of the oysters. All of the seven cases in persons giving a history of not having eaten either raw or undercooked oysters were comprised in the group of cases occurring among the residents of southeast Washington, and are definitely attributable to water infection (see pp. 21 to 23). The two cases in persons giving a history of having eaten undercooked oysters, but no raw oysters, also are included in the group of cases attributed to the localized water infection in southeast Washington.

The large proportion of cases among raw oyster eaters is an outstanding feature in the history of the outbreak. An estimate, based

on general observations and on limited specific data, is that less than 20 per cent of the total population of the city ate raw oysters, and that less than 10 per cent ate raw shell oysters within the 30 days of November, 1924 (see pp. 29 and 30).

Of the 34 cases in persons from whom definite histories with respect to the eating of oysters were obtained, 23, or 67.6 per cent, were in persons who ate raw shell oysters within the 30 days immediately before onset of illness—10 frequently, 11 occasionally, and 2 only once. Of these 23 cases, 20 were in persons who, according to their statements and to our findings in a diligent and persistent effort to trace as exactly as possible the oysters involved back to their sources, were either exclusively or potentially exposed to raw shell oysters distributed by a producing company operating within the vicinity of West Sayville, N. Y. This company is designated hereafter in this report as "company A."

By exclusive exposure is meant that the case was in a person who within the period of usual incubation of typhoid fever before onset of the illness ate raw shell oysters of a kind supplied by a given producing company and ate them only at some place or places where the oysters of that kind served were, according to all evidence obtainable, derived entirely from the supply distributed by that producing company. By potential exposure is meant that the person ate raw shell oysters at some place or places where oysters of the kind eaten were, according to all evidence obtainable, served from a supply derived in part from the designated producing company and in part from one or more other original shippers. In the endeavor to trace the source of the oysters, the possibility of substitution at every point along the line at which it might have occurred was carefully considered. The statements from the different sources of information were checked against each other. The chances for error were carefully weighed. When every datum obtained in such an inquiry dovetails with all the others and points in one direction, what may appear in the early part of the inquiry as a strong probability becomes a practical certainty.

The statements of the persons affected as to the kind of raw shell oysters eaten were as follows: Eighteen ate only small oysters designated on the menu as "Bluepoints;" one ate "Bluepoints" and also medium-sized oysters designated on the menu as "Cape Cods;" one ate "Bluepoints" and also large-sized oysters designated on the menu as "Lynnhavens;" one ate medium-sized oysters the designation of which on the menu could not be recalled; and one ate both medium and large-sized oysters the designation of which on the menu could not be recalled. Thus, 20 of these 23 persons were exposed to "Bluepoint" shell oysters.

The small proportion of cases among eaters of large or medium-sized raw shell oysters is striking, in view of the fact that such oysters derived from comparatively near-by waters compose a very large proportion of the raw shell oysters marketed and eaten in Washington. The small proportion of cases furnished by eaters of raw shucked oysters is also striking.

Almost all of the raw shell oysters to which the persons affected were exposed were eaten in restaurants. The incidence of the disease was especially high among persons who may be designated as particular oyster eaters—persons who liked only one kind of oyster and went to restaurants where they would be served with that kind—viz, "Bluepoint" oysters with the general features of those produced in the beds of Great South Bay or within that general vicinity.

Of the 23 cases among eaters of raw shell oysters, 18 were in women and 5 were in men. The predilection of women oyster eaters for small oysters, "Bluepoints," instead of large or mediums, should be considered in connection with the markedly excessive case rate in women 20–34 years of age (see pp. 15 to 17).

If the principal oyster producing companies had furnished us with a complete list of their shipments, as they were earnestly requested to do, our efforts to determine the source or sources of the oysters which possibly could have operated in the spread of the infection would have been very much lightened and simplified. Some of the companies cooperated with us in this respect, but most of them did not.

By canvassing wholesale and retail dealers in Washington, who bought from producing companies direct or through wholesalers in other cities, and by tapping every other available source of definite information, we obtained sufficient data to indicate (1) that less than 15 per cent of the total supply of raw shell oysters eaten in Washington within the period of causation of the outbreak was furnished by the several producing or distributing companies operating within the vicinity of West Sayville, N. Y.; and (2) that less than 5 per cent of the total supply was furnished by "company A."

Thus, it appears that persons exposed either exclusively or potentially to raw shell oysters distributed by "company A," though composing less than 10 per cent of the raw shell oyster eaters and less than 1 per cent of the total population of the city, furnished over 86 per cent of the cases occurring among raw shell oyster eaters, and over 58 per cent of the primary cases developing in the total residential population within the period of the outbreak.

The following tabular statement presents the data obtained with respect to exposure of the 23 cases among the eaters of raw shell oysters to the raw shell oysters derived from the several producing or

distributing companies operating within the immediate vicinity of West Sayville, N. Y.:

Company	Approximate number of barrels of raw shell oysters distributed in Washington within period Sept. 1–Dec. 1, 1924	Number of cases of typhoid fever among persons exposed within causation period of outbreak.	
		Potentially	Exclusively
A	125	20	9
B	300	8	0
C	90	4	0
D	40	3	0

Of the eight cases potentially exposed to company B oysters, seven were also potentially exposed to company A oysters; of the four cases exposed to company C oysters, two were also potentially exposed to company A oysters; and all three of the cases potentially exposed to company D oysters were also potentially exposed to company A oysters. Of the three cases potentially exposed to "Bluepoint" oysters distributed by company D, two were so exposed only at New York City restaurants and one at both a New York City restaurant and a Washington restaurant. The apparently large ratio of typhoid cases to barrels of oysters distributed in Washington by company D is due to the fact that two of the three cases had their potential exposure to such oysters in New York restaurants.

A canvass was made of 38 of the principal high grade restaurants, mainly at hotels or clubs, in Washington to ascertain the kind or kinds and source or sources of raw shell oysters served under the menu designation of "Bluepoints." Apparently complete and trustworthy statements were obtained from the managements of 37 of such restaurants. Of these 37 restaurants, 11 served "Bluepoint" raw shell oysters derived wholly or in part from "company A." The patrons of these 11 restaurants furnished 21 of the cases of typhoid fever recorded among the patrons of Washington restaurants. The patrons of the other 26 restaurants where "Bluepoints" either were not served or where those served were derived from companies B, C, or D, or some other company either alone or in combination, but none from company A, furnished only nine of the cases of typhoid fever recorded, and of these nine cases six were patrons also of restaurants served with "Bluepoint" oysters supplied wholly or in part by company A. The patrons of the latter group of restaurants (those not receiving any of their oyster supply from company A) far outnumber those of the former group. The difference in typhoid fever incidence among these two groups of restaurant patrons is striking and significant. It is not conceivable, in the face of the data

we have, that such a difference possibly could be defined among two large groups of patrons of Washington restaurants if the restaurants were classified by source of celery, lettuce, milk, ice cream, butter, or any other possible factor, except oysters, in the conveyance of typhoid infection. If some hypothesist should undertake to attribute the infection to "carriers" among workers in the restaurants, he would have overwhelming difficulty in explaining why the infection was distributed so excessively among the patrons who happened to eat raw shell oysters of a certain kind distributed in such large part, necessarily, from the evidence, by company A.

Every one of the restaurants supplied in whole or in part with shell oysters by company A had one or more cases of typhoid fever among its patrons, while eighteen of the restaurants not so supplied by that company had no case among their patrons.

According to the epidemiological evidence obtained from the case histories here, whatever typhoid infection was spread by company A oysters in Washington, within the period of causation of the outbreak, may have been either in infected oysters uniformly distributed throughout all the barrel lots derived from that company or in infected oysters composing but a small part of each of possibly not more than 15 or 20 of the barrel lots.

Only 2 of the 36 cases gave a history of eating raw shell clams within the 30 days immediately before onset of illness, and both of these were exposed also to company A raw shell "Bluepoint" oysters. From such definite data as could be obtained it is estimated that at least 10,000 persons in Washington ate raw clams within the period of causation of the outbreak. It is not only remarkable but highly significant that such a small proportion of the cases was furnished by eaters either of raw clams or of oysters derived from supplies other than that of company A.

The persons, probably totalling at least 60,000, who ate either raw clams or raw oysters other than company A's in the Washington restaurants—many of them in the restaurants where company A oysters were served—presumably were exposed in those restaurants to other possible vectors of typhoid infection—such as raw vegetables, fruits, milk, cream, ice cream, butter, cheese, bread, etc.—to about the same degree as were those who ate company A raw shell oysters. Thus these persons served as a "control" in the study of the situation.

CANVASS OF UNAFFECTED PERSONS

With a view to ascertaining certain salient food habits of a sample group of the normal population for comparison with those of the persons who became infected with typhoid within the causation period of the outbreak, a canvass was made in two blocks of the

northwest section and in one each of the northeast, southeast, and southwest sections of Washington. This canvass was made in the early evening hours in order to have a chance to find the working members of the household at home. The persons interviewed were about equally divided among men and women. The 30 days of November composed the period to which the inquiry applied. This month was suitable for the "control" study (1) because it covered a considerable part of the period of causation of the outbreak and (2) because it contained three reminder dates, election day, armistice day, and Thanksgiving Day.

Table No. 4 presents the findings.

TABLE No. 4.—*Statements of persons canvassed in general population of Washington, D. C., as to whether certain raw foods were eaten by them in November, 1924*

Section of city in which block canvassed is located	Number persons canvassed	Number of persons who ate—					
		Raw oysters			Raw clams	Raw lettuce	Raw celery
		Shell	Shucked	Total			
Northwest	30	5	4	9	2	23	17
Do	79	4	6	10	1	69	52
Northeast	30	1	0	1	0	24	24
Southeast	150	8	7	15	0	100	125
Southwest	110	1	10	11	3	42	45
Total	399	19	27	46	6	258	263
Percentage		4.7+	6.7+	11.5	1.5	64+	66

While the proportion in this group giving a history of having eaten raw lettuce or celery is quite close to that in the group stricken with typhoid fever, there is a remarkable and significant degree of difference between the histories of the two groups with respect to the eating of raw oysters.

The following tabular statement presents the comparison·

	Percentage ate—					
	Raw oysters			Raw clams	Raw lettuce	Raw celery
	Shell	Shucked	Total			
Typhoid patients	67.6	5.8	73.4	5.5	58.3	63.8
Control group	4.7+	6.7+	11.5	1.5	64+	66

It is interesting to note that the percentage of raw clam eaters is larger for the typhoid group but that the percentage of shucked oyster eaters is larger for the control group.

SUMMARY

Definite and reasonably complete epidemiological data were obtained for 41 of the 63 cases of typhoid fever reported in the District of Columbia from December 1, 1924, to January 16, 1925. Of these 41 cases, 2 were in persons who were away from Washington for all or most of the period of 30 days immediately before onset of illness and who within that period ate raw shell "Bluepoint" oysters served in New York City restaurants supplied wholly or in part by company A. These two cases are recorded as away from Washington infections and are attributed to oyster-borne infection.

Of the 39 cases originating within the District of Columbia, 23 gave a definite history of exposure to raw shell oysters.

Of the 16 cases in persons who were either sure they did not or were not sure they did eat raw shell oysters, 2 were exposed to raw shucked oysters from sources which were not definitely determined; 3 are definitely attributable to personal contact infection with a previous case; and 9 are definitely attributable to localized water-borne infection in southeast Washington.

Of the 23 cases giving a history of exposure to raw shell oysters, 20 were either exclusively or potentially exposed to such oysters supplied by company A and are definitely attributable to oyster-borne infection.

CONCLUSION

The main factor in the spread of the infection causing the outbreak of typhoid fever in the District of Columbia in November and December, 1924, was raw shell oysters supplied by company A, and among contributing factors were personal contact and water.

Section III

THE OUTBREAK IN CHICAGO, ILL., AND ITS SUBURBS

On November 30, 1924, four cases of typhoid fever were reported to the Chicago health department. From October 1 to November 29, 1924, 38 cases were reported, or an average of only about 4 cases a week. From November 30 to January 21, inclusive, a total of 129 cases of typhoid fever was reported. This represents a period of 53 days. The typhoid fever expectancy for such period at this time of the year in Chicago is about 33 cases. The daily report of cases during the period of excessive prevalence is given in Table No. 5. Within this same period 21 cases were reported in Evanston, 4 cases in Wilmette, and 9 cases in Oak Park. These towns are all immediate suburbs of Chicago. In Table No. 6 is given the morbidity rate per 100,000 population for the above-mentioned cities. In Chicago the cases were grouped very largely in certain wards of the city. Many of the wards failed to show any increase. If the increase is studied by wards, Table No. 7, it will be seen that the incidence in certain wards of Chicago nearly approximates that for the suburbs, and that it closely follows economic lines.

TABLE No. 5.—*Typhoid fever cases in Chicago reported by days from October 1, 1924, to February 1, 1925*

Date	Cases	Date	Cases	Date	Cases	Date	Cases
Oct. 1	0	Nov. 1	2	Dec. 1	0	Jan. 1	0
2	2	2	0	2	0	2	5
3	0	3	0	3	4	3	5
4	0	4	0	4	2	4	0
5	0	5	2	5	4	5	2
6	1	6	0	6	1	6	3
7	2	7	1	7	0	7	1
8	1	8	0	8	5	8	1
9	0	9	0	9	3	9	0
10	0	10	0	10	3	10	3
11	1	11	0	11	6	11	0
12	0	12	0	12	3	12	3
13	2	13	2	13	5	13	1
14	1	14	0	14	0	14	0
15	0	15	1	15	4	15	0
16	1	16	0	16	12	16	0
17	2	17	0	17	3	17	1
18	0	18	0	18	3	18	0
19	0	19	0	19	4	19	1
20	0	20	2	20	4	20	2
21	0	21	0	21	0	21	3
22	2	22	2	22	0	22	1
23	0	23	0	23	2	23	1
24	3	24	0	24	5	24	1
25	1	25	0	25	0	25	0
26	0	26	2	26	2	26	0
27	0	27	0	27	8	27	2
28	1	28	0	28	0	28	0
29	3	29	0	29	4	29	0
30	0	30	4	30	3	30	1
31	1			31	5	31	1

TABLE NO. 6.—*Typhoid fever morbidity per 100,000 population in the period November 30, 1924, to January 21, 1925, in Chicago, Evanston, Wilmette, and Oak Park, Ill.*

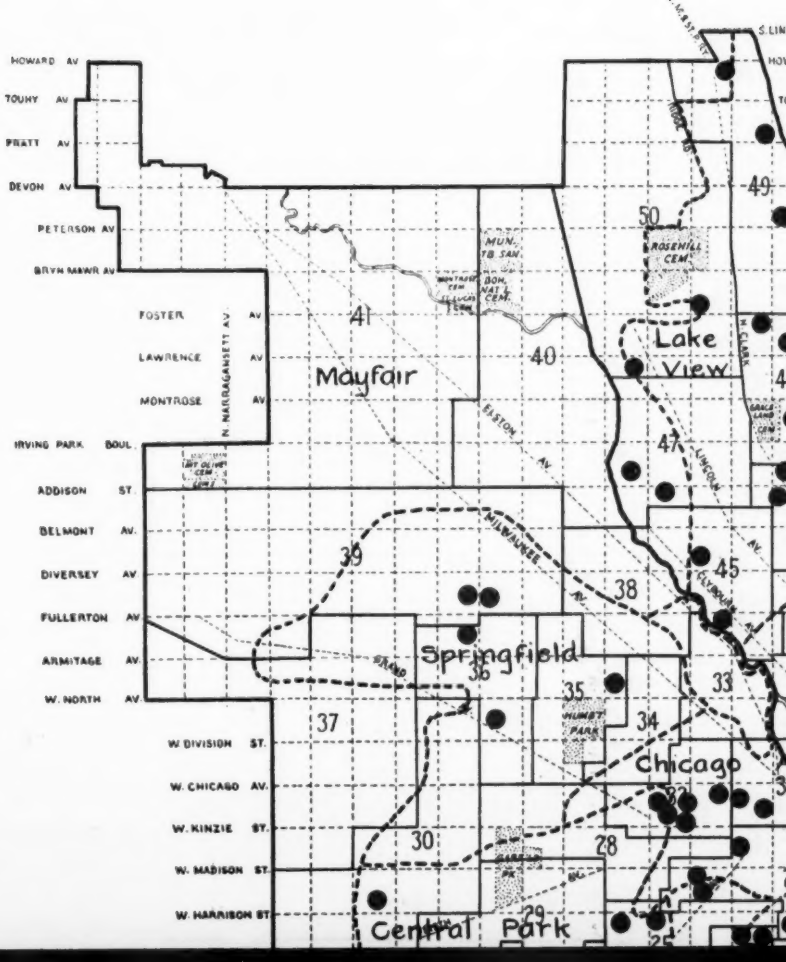
City	Estimated population Dec. 1, 1924	Total cases	Case rate per 100,000
Chicago	2,963,241	129	4.4
Twelve city wards involved in the outbreak	776,164	88	11.4
Oak Park	50,183	9	17.9
Wilmette	9,230	4	43.3
Evanston	43,441	21	48.5

TABLE NO. 7.—*Typhoid fever morbidity per 100,000 population by wards in Chicago within the period November 30, 1924, to January 21, 1925. Wards grouped with regard to their apparent economic condition*

City	Estimated population Jan. 1, 1925	Total cases	Case rate per 100,000
GROUP I.—*Uniformly excellent or good economic conditions*			
Ward 46	57,640	13	22.6
Ward 49	58,306	13	22.4
Ward 48	57,624	12	20.8
Ward 42	58,707	9	15.3
Ward 5	64,077	9	14.0
Ward 44	52,959	6	11.3
Average			17.7
GROUP II.—*Economically mixed, average below Group I*			
Ward 7	62,660	7	11.2
Ward 6	57,516	5	8.6
Ward 4	66,941	5	7.5
Ward 43	61,272	3	4.9
Ward 47	61,043	2	4.9
Ward 45	58,409	2	3.4
Average			6.5
GROUP III.—*Predominating economic condition fair or poor*			
All other wards	2,240,623	43	1.9

GEOGRAPHIC DISTRIBUTION

Maps Nos. 3, 4, 5, and 6, show the distribution of typhoid fever in Chicago during four different periods: (1) a normal summer period, (2) a normal autumn period, (3) a period of excessive prevalence in the fall of 1923, and (4) the period November 30, 1924, to January 21, 1925. The maps are subdivided into wards which are numbered consecutively from 1 to 50. The heavy solid line meandering south from the north boundary of Chicago to meet the Lake near Grant Park and then going southwest to leave the city near West Pershing Road represents the North Chicago drainage canal and the Chicago River, respectively. The irregular areas bounded by heavy dotted lines represent municipal water pumping areas. There are eleven of such areas, each supplied by a separate set of pumps.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PRATT AV
DEVON AV
PETERSON AV
BRYN MAWR AV
FOSTER AV
LAWRENCE AV
MONTROSE AV
IRVING PARK BOUL.
ADDISON ST.
BELMONT AV.
DIVERSEY AV
FULLERTON AV
ARMITAGE AV.
W. NORTH AV.
W. DIVISION ST.
W. CHICAGO AV.
W. KINZIE ST.
W. MADISON ST.
W. HARRISON ST.
N. NARRAGANSETT AV.
MUN. TB SAN
BOH. NAT'L CEM.
ROSEHILL CEM.
EVERGREEN CEM.
ODD FELLOWS CEM.
MONTEFIORE CEM.
ST. HENRY'S CEM.
ST. OLIVE CEM.
ELSTON AV.
MILWAUKEE AV.
LINCOLN AV.
KEDZIE AV.
HUMBOLDT PARK
GARFIELD PK.
41
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39
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36
35
34
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29
28
50
49
47
45
Mayfair
Lake View
Springfield
Chicago
Central Park

S. LINE CALVARY CEM.
HOWARD AV.
TOUHY AV.
PRATT AV.
DEVON AV.
PETERSON AV.
BRYN MAWR AV.
FOSTER AV.
LAWRENCE AV.
MONTROSE AV.
IRVING PARK BOUL.
ADDISON ST.
BELMONT AV.
DIVERSEY PKW.
FULLERTON PKW.
CENTER ST.
E. NORTH AV.
E. DIVISION ST.
E. CHICAGO AV.
E. KINZIE ST.
E. MADISON ST.
E. HARRISON ST.
SEDGWICK ST.
N. STATE ST.
SOUTH PARK AV
COTTAGE GROVE AV
WOODLAWN AV.
ROSEHILL CEM.
Lake View
LINCOLN AV.
CLYBOURN AV.
LINCOLN PK.
49
48
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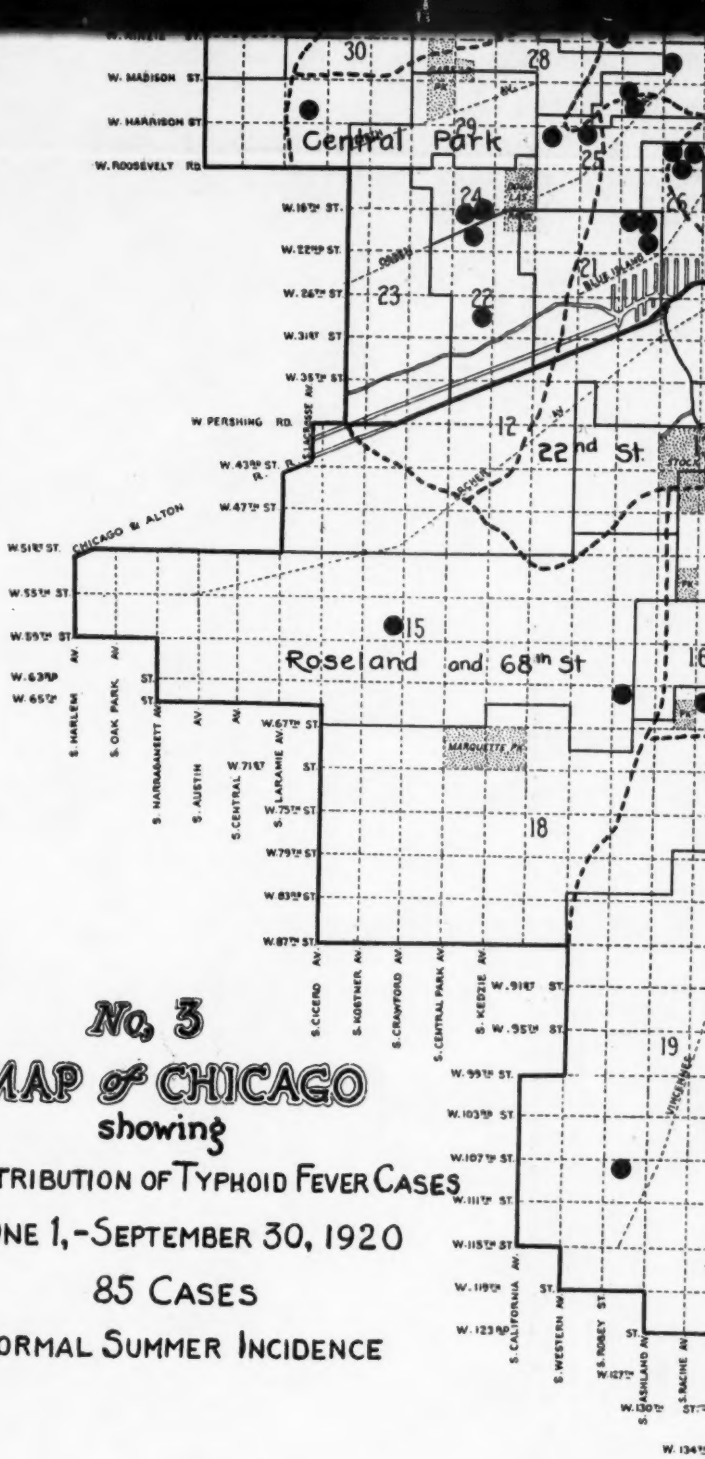
31
27
LAKE MICHIGAN



No. 3

MAP of CHICAGO

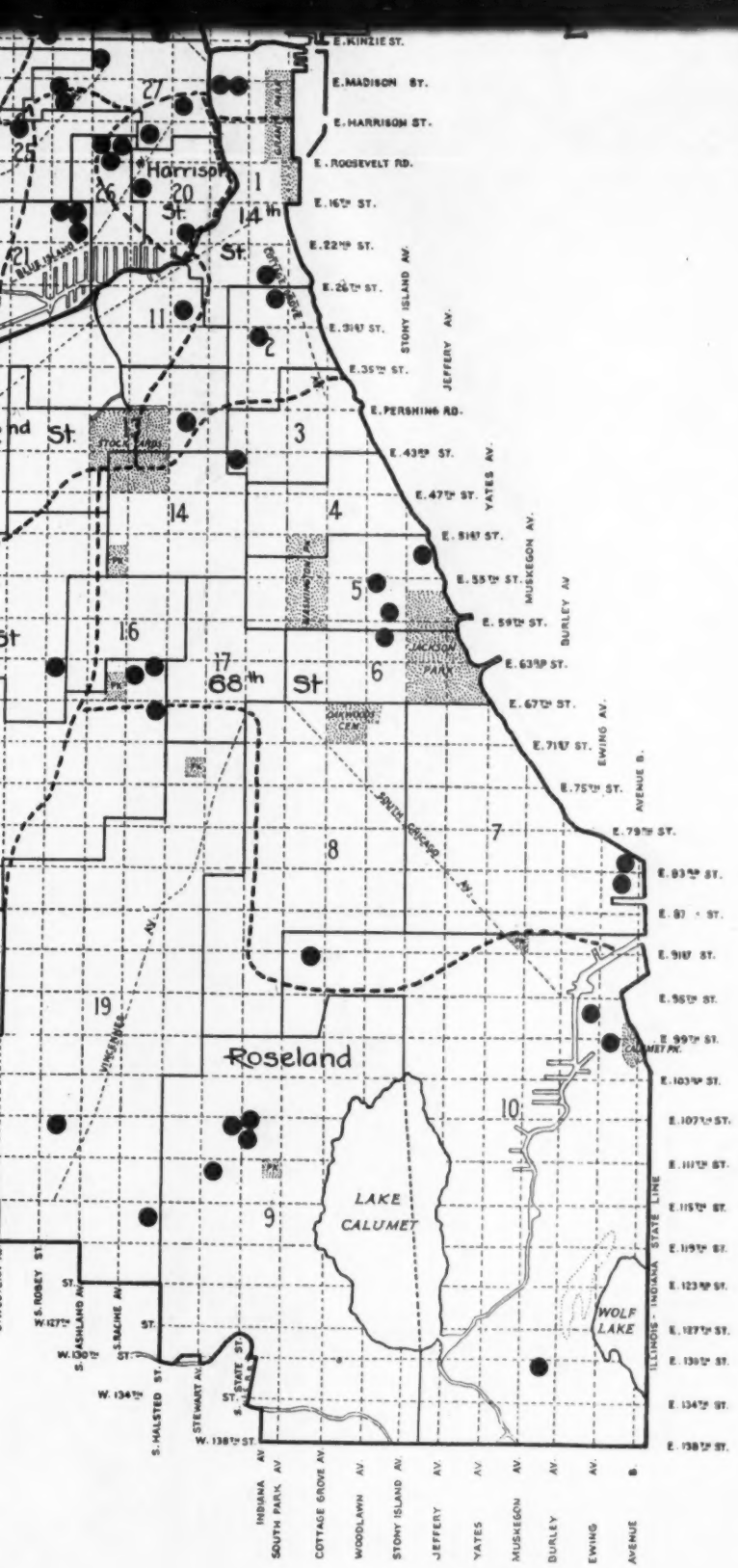
showing

DISTRIBUTION OF TYPHOID FEVER CASES

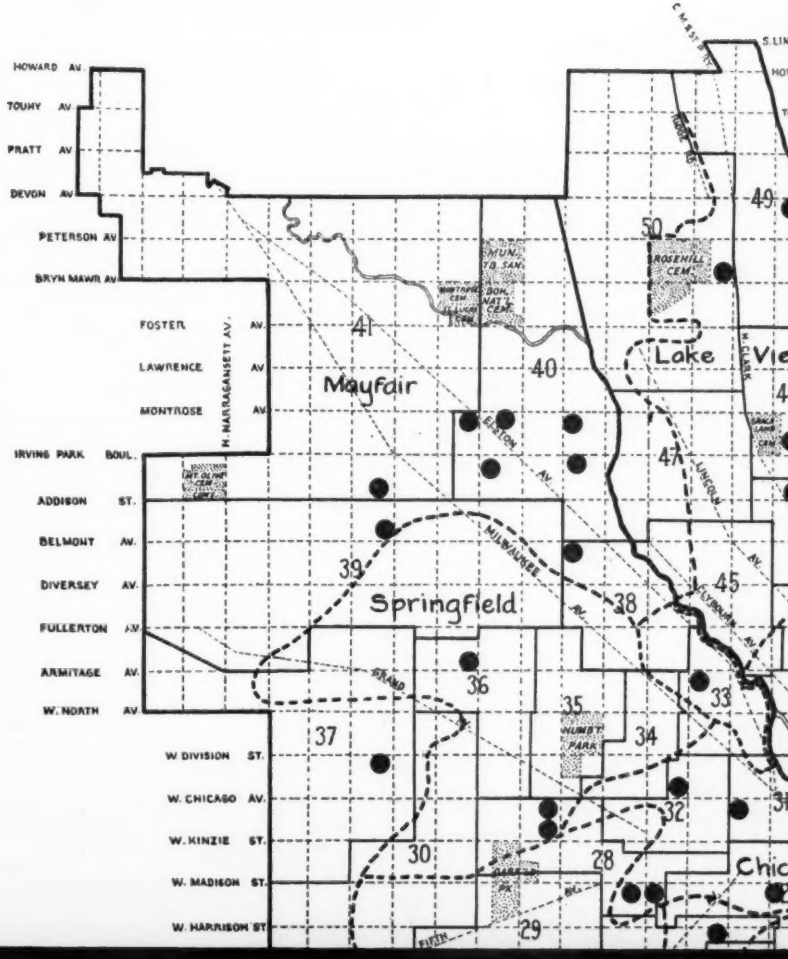
JUNE 1, - SEPTEMBER 30, 1920

85 CASES

NORMAL SUMMER INCIDENCE



37639—25†. (Face p. 34.) No. 1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PRATT AV.
DEVON AV.
PETERSON AV.
BRYN MAWR AV.
FOSTER AV.
LAWRENCE AV.
MONTROSE AV.
IRVING PARK BOUL.
ADDISON ST.
BELMONT AV.
DIVERSEY AV.
FULLERTON AV.
ARMITAGE AV.
W. NORTH AV.
W. DIVISION ST.
W. CHICAGO AV.
W. KINZIE ST.
W. MADISON ST.
W. HARRISON ST.
N. NARRAGANSETT AV.
Mayfair
Springfield
Lake
MUN. T.B. SAN.
BOH. NAT'L. CEM.
ROSEHILL CEM.
MT. OLIVE CEM.
ELSTON AV.
MILWAUKEE AV.
GRAND
LINCOLN AV.
HUMBT. PARK
N. CLARK
FIFTH
41
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S. LINE CALVARY CEM.
HOWARD AV.
TOUHY AV.
PRATT AV.
SEDGWICK ST.
DEVON AV.
PETERSON AV.
BRYN MAWR AV.
FOSTER AV.
N. STATE ST.
LAWRENCE AV.
SOUTH PARK AV.
MONTROSE AV.
IRVING PARK BOUL.
COTTAGE GROVE AV.
ADDISON ST.
BELMONT AV.
DIVERSEY PKW.
FULLERTON PKW.
CENTER ST.
E. NORTH AV.
WOODLAWN AV.
E. DIVISION ST.
E. CHICAGO AV.
E. KINZIE ST.
E. MADISON ST.
E. HARRISON ST.
Lake View
Chicago Ave
49
48
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33
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31
27
LAKE MICHIGAN

No. 4

MAP of CHICAGO

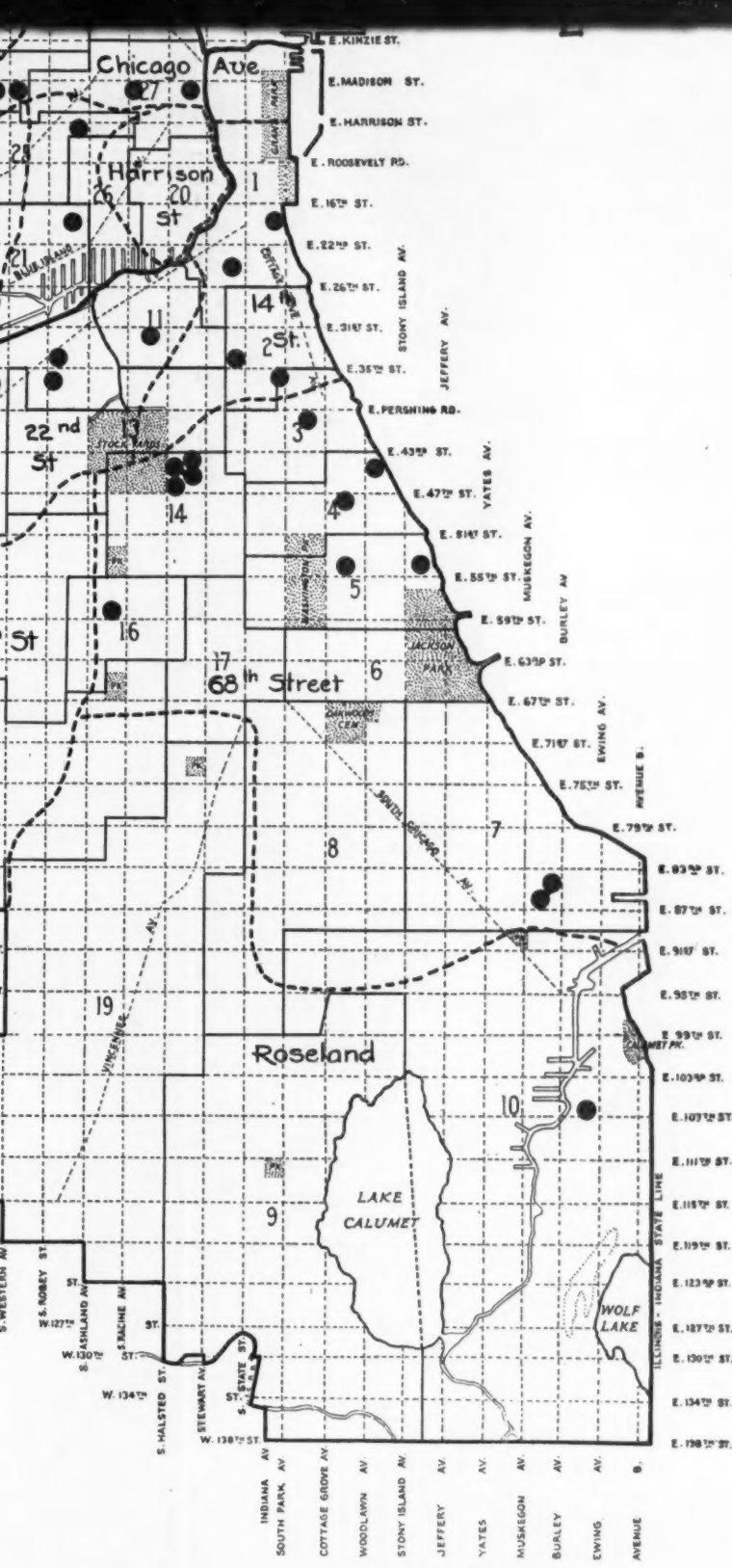
showing

DISTRIBUTION OF TYPHOID FEVER CASES

NOV. 1. 1920 – JAN. 15, 1921

55 CASES

NORMAL FALL INCIDENCE



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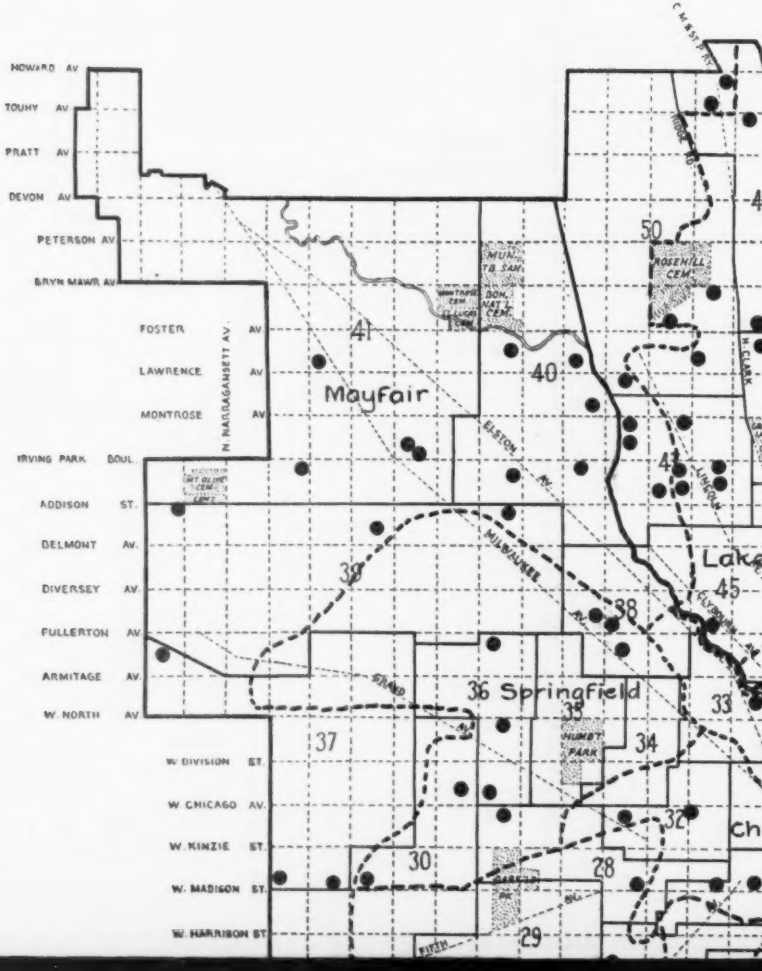
HOWARD AV.
TOUHY AV.
PRATT AV.
DEVON AV.
PETERSON AV.
BRYN MAWR AV.
FOSTER AV.
LAWRENCE AV.
MONTROSE AV.
IRVING PARK BOUL.
ADDISON ST.
DELMONT AV.
DIVERSEY AV.
FULLERTON AV.
ARMITAGE AV.
W. NORTH AV.
W. DIVISION ST.
W. CHICAGO AV.
W. KINZIE ST.
W. MADISON ST.
W. HARRISON ST.
N. NARRAGANSETT AV.
Mayfair
Springfield
Humboldt Park
Garfield Park
Rosehill Cem.
Milwaukee
Elston
Lincoln
Stand
Fifth
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S. LINE CALVARY CEM.
HOWARD AV.
TOUHY AV.
PRATT AV.
SEDGWICK ST.
DEVON AV.
49
50
PETERSON AV.
ROSEHILL CEM.
BRYN MAWR AV.
FOSTER AV.
N. STATE ST.
LAWRENCE AV.
48
MONTROSE AV.
SOUTH PARK AV.
IRVING PARK BOUL.
COTTAGE GROVE AV.
ADDISON ST.
46
BELMONT AV.
Lake View
45
DIVERSEY PKW.
44
FULLERTON PKW.
CENTER ST.
WOODLAWN AV.
33
43
E. NORTH AV.
E. DIVISION ST.
31
42
E. CHICAGO AV.
Chicago Ave.
E. KINZIE ST.
E. MADISON ST.
E. HARRISON ST.
LAKE MICHIGAN

No. 5.

MAP of CHICAGO

showing

DISTRIBUTION OF TYPHOID FEVER CASES

NOV. 19 - DEC. 22, 1923

252 CASES

LOCALIZED WATER BORNE INFECTION

E. KINZIE ST.
E. MADISON ST.
E. HARRISON ST.
E. ROOSEVELT RD.
E. 16TH ST.
E. 22ND ST.
E. 26TH ST
E. 31ST ST.
E. 35TH ST.
E. PERSHING RD.
E. 43RD ST.
E. 47TH ST.
E. 51ST ST
E. 55TH ST.
E. 59TH ST.
E. 63RD ST.
E. 67TH ST.
E. 71ST ST.
E. 75TH ST.
E. 79TH ST.
E. 83RD ST.
E. 87TH ST.
E. 91ST ST.
E. 95TH ST.
E. 99TH ST.
E. 103RD ST.
E. 107TH ST.
E. 111TH ST.
E. 115TH ST.
E. 119TH ST.
E. 123RD ST.
E. 127TH ST.
E. 130TH ST.
E. 134TH ST.
E. 138TH ST.
Harrison St.
14th St.
22nd St.
68th Street
Roseland
LAKE CALUMET
WOLF LAKE
BLUE ISLAND
STONY ISLAND AV.
JEFFERY AV.
YATES AV.
MUSKEGON AV.
BURLEY AV
EWING AV.
AVENUE O
ILLINOIS - INDIANA STATE LINE
INDIANA SOUTH PARK AV.
COTTAGE GROVE AV.
WOODLAWN AV.
S. WESTERN AV.
S. ASHLAND AV.
S. RACINE AV.
S. HALSTED ST.
STEWART AV.
S. STATE ST.
W. 127TH ST.
W. 130TH ST.
W. 134TH ST.
W. 138TH ST.
1
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The distribution in a normal summer, as shown on map No. 3, is fairly uniform throughout the city. The population of each ward in the city ranges between 50,000 and 65,000 persons. In one or two wards west of the Chicago River, south of Chicago Avenue and north of Sixteenth Street, the incidence of typhoid fever in summer is usually slightly higher than the average for the whole city. In this area the general sanitary and economic conditions are poor; also there is over-crowding. One hundred and twenty-two days are included in the summer period referred to on the spot map. Eighty-five cases were reported during this time, but if calculated for 53 days, the period of the recent outbreak, there would have been only 37 cases.

Map No. 4 shows the distribution by place of residence, of the 55 cases reported during a normal autumn period of 76 days. Here again was a rather uniform distribution throughout the city. In fact, if the time periods included in maps Nos. 3 and 4 had been made the same, the similarity of the two maps would have been such that they could not have been differentiated.

In the autumn of 1923, beginning on November 19 and ending December 22, there occurred a very definite outbreak of typhoid fever involving only a small area of the city. (Table No. 8.) Two hundred and fifty-two cases were reported within 34 days. Map No. 5 shows the limited area and the sharp outlines of this outbreak. It will be seen that the cases are confined practically exclusively to the area supplied with drinking water from the Sixty-eighth Street pumps.

TABLE No. 8.—*Typhoid fever cases in Chicago reported by days from November 1 to December 31, 1923*

Date	Cases	Date	Cases	Date	Cases	Date	Cases
Nov. 1	0	Nov. 16	5	Dec. 1	11	Dec. 16	0
2	4	17	4	2	0	17	2
3	2	18	0	3	13	18	11
4	0	19	7	4	15	19	7
5	4	20	1	5	10	20	3
6	1	21	9	6	6	21	3
7	2	22	10	7	11	22	5
8	3	23	9	8	8	23	0
9	5	24	10	9	0	24	2
10	4	25	3	10	8	25	0
11	0	26	14	11	9	26	3
12	4	27	13	12	2	27	3
13	7	28	18	13	11	28	1
14	2	29	12	14	3	29	3
15	0	30	0	15	8	30	0
						31	1

The epidemiological evidence is very concluisve that this was a water-borne outbreak of typhoid fever. The method of water supply to Chicago makes it entirely possible that this could have been a water outbreak which need not have extended beyond the zone supplied by the Sixty-eighth Street pumps, and, in fact, not beyond the zone supplied by only one of the pumps operating in the Sixty-eighth

Street pump house. A detailed report of the conditions operating at that time is published in the Engineering News Record of January 17, 1924, pages 116 to 121.[1]

The geographic distribution of cases during the recent outbreak is shown on map No. 6. This is a very different grouping of cases than that of the 1923 outbreak (map No. 5), and also considerably different from the normal summer or autumn distribution (maps Nos. 3 and 4). In fact, if the normal expectancy of 30 cases were to be removed from map No. 6 on a basis of distribution as is shown on map No. 4, which is the normal fall distribution, it would be shown that nearly all the excess cases for the 1924 period are localized in two sharply defined areas; one north of the Chicago River and the other south of Forty-seventh Street, both bounded on the east by the lake and extending approximately 1 mile westward.

Of especial interest and importance is the prevalence and geographic distribution of the cases in Evanston. For the purposes of this study Evanston is a direct continuation of Chicago to the northward, differing only in its water supply. The normal typhoid fever expectancy for the period of the recent outbreak is only one or two cases. The actual morbidity rate for the outbreak was 48.5 per 100,000 population (Table No. 6). Map No. 7 shows the geographic distribution, which is essentially the same as in North Chicago, being confined very largely to a strip of land adjacent to the lake front.

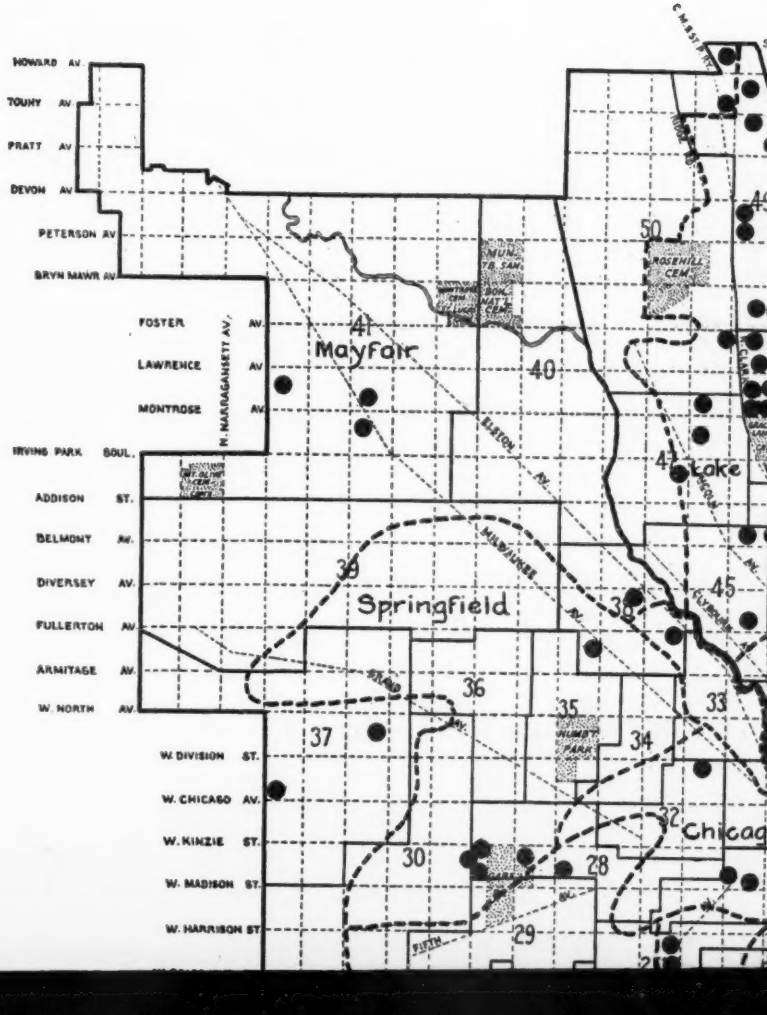
AGE-SEX DISTRIBUTION

There are certain points of difference in the distribution of cases with regard to age and sex in the recent outbreak which do not occur during periods of normal expectancy or even during the 1923 outbreak. Table No. 9 gives the age and sex distribution by three age groups for the recent outbreak, the one of 1923, and the two control periods of normal expectancy. In both the normal summer

TABLE NO. 9.—*Age and sex distribution of typhoid fever cases in Chicago within the recent outbreak, November 30, 1924, to January 21, 1925; also for three other periods*

Age groups	Outbreak of Nov. 30, 1924, to Jan. 21, 1925		Outbreak of Nov. 19, 1923, to Dec. 22, 1923		Normal autumn, Nov. 1, 1920, to Jan. 15, 1921		Normal summer, June 1, 1920, to Sept. 30, 1920	
	Male	Female	Male	Female	Male	Female	Male	Female
0-19 years	10	6	34	17	10	6	24	20
20-34 years	23	45	49	54	15	6	15	8
34-74 years	28	12	50	48	12	6	12	6
	61	63	133	119	37	18	51	34
Total	124		252		55		85	

[1] 1924. November typhoid epidemic in part of Chicago. Vol. 92, No. 116.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PRATT AV.
DEVON AV.
PETERSON AV.
BRYN MAWR AV.
FOSTER AV.
LAWRENCE AV.
MONTROSE AV.
N. NARRAGANSETT AV.
IRVING PARK BOUL.
ADDISON ST.
BELMONT AV.
DIVERSEY AV.
FULLERTON AV.
ARMITAGE AV.
W. NORTH AV.
W. DIVISION ST.
W. CHICAGO AV.
W. KINZIE ST.
W. MADISON ST.
W. HARRISON ST.
Mayfair
Springfield
Lake
Chicag
ELSTON AV.
MILWAUKEE AV.
STATE
Fifth
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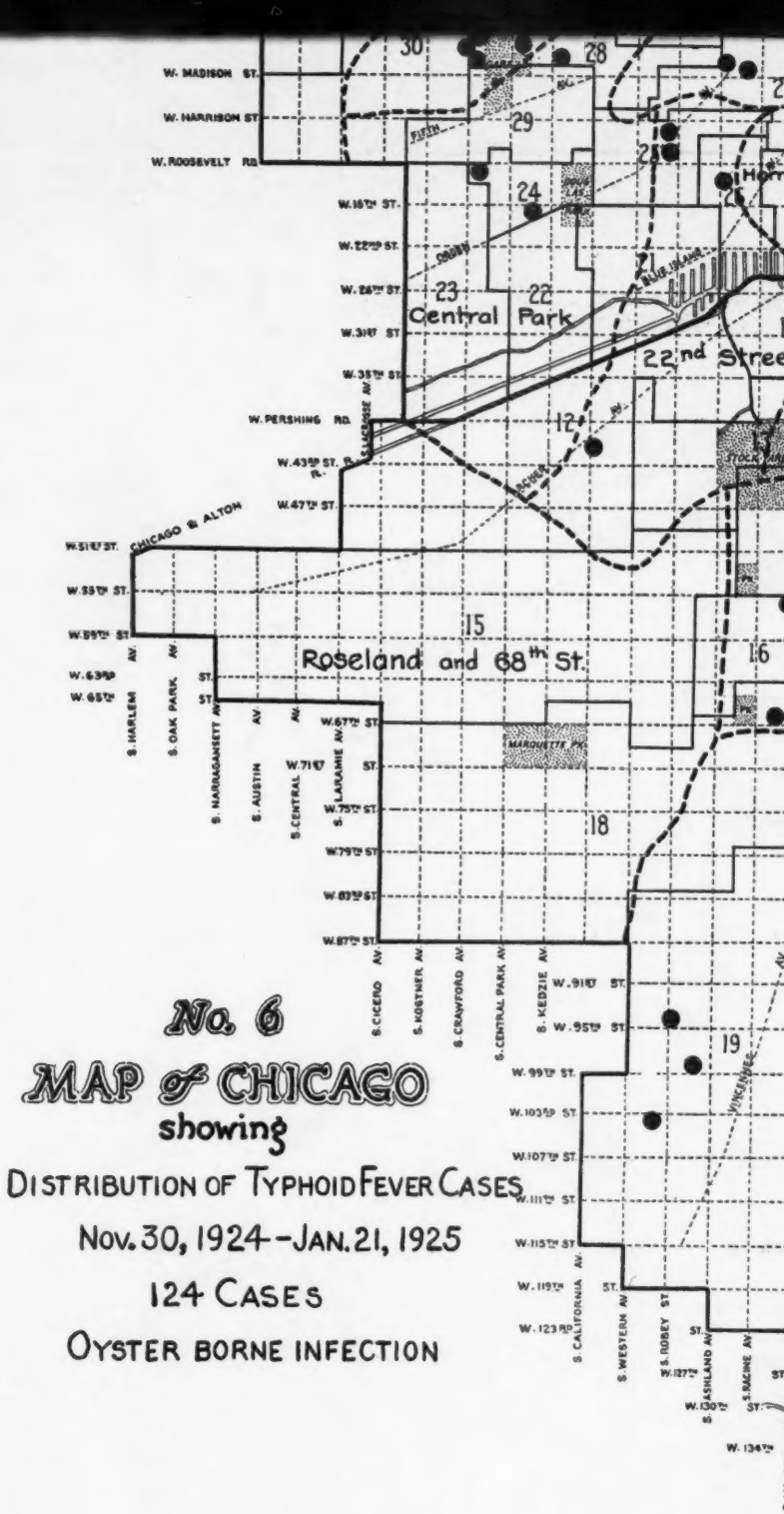
S. LINE CALVARY CEM.
HOWARD AV.
TOUHY AV.
PRATT AV.
DEVON AV.
PETERSON AV.
BRYN MAWR AV.
FOSTER AV.
LAWRENCE AV.
MONTROSE AV.
IRVING PARK BOUL.
ADDISON ST.
BELMONT AV.
DIVERSEY PKW.
FULLERTON PKW.
CENTER ST.
E. NORTH AV.
E. DIVISION ST.
E. CHICAGO AV.
E. KINZIE ST.
E. MADISON ST.
E. HARRISON ST.
SEDGWICK ST.
N. STATE
SOUTH PARK AV.
COTTAGE GROVE AV.
WOODLAWN AV.
ROSEHILL CEM.
Lake View
Chicago Ave
LAKE MICHIGAN



No. 6

MAP of CHICAGO

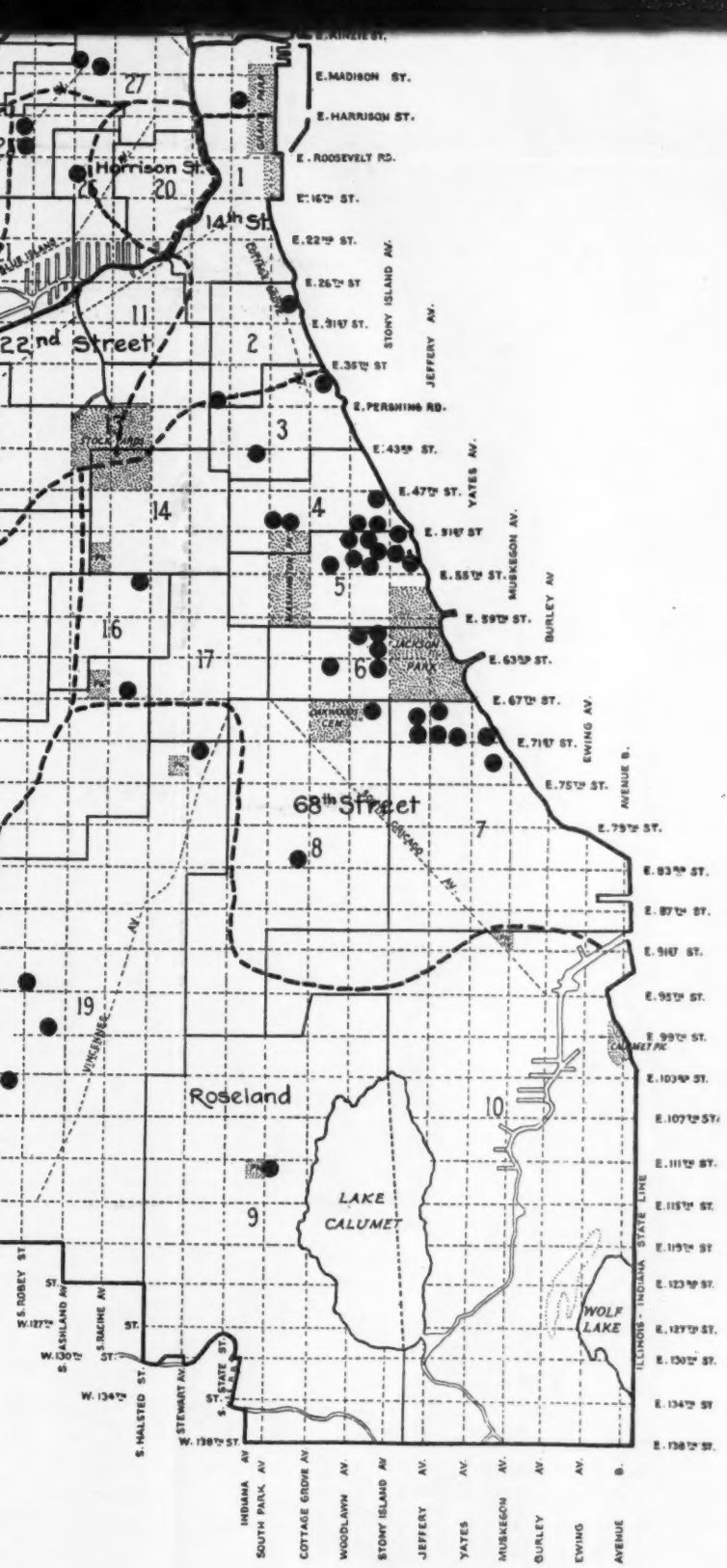
showing

DISTRIBUTION OF TYPHOID FEVER CASES

NOV. 30, 1924 – JAN. 21, 1925

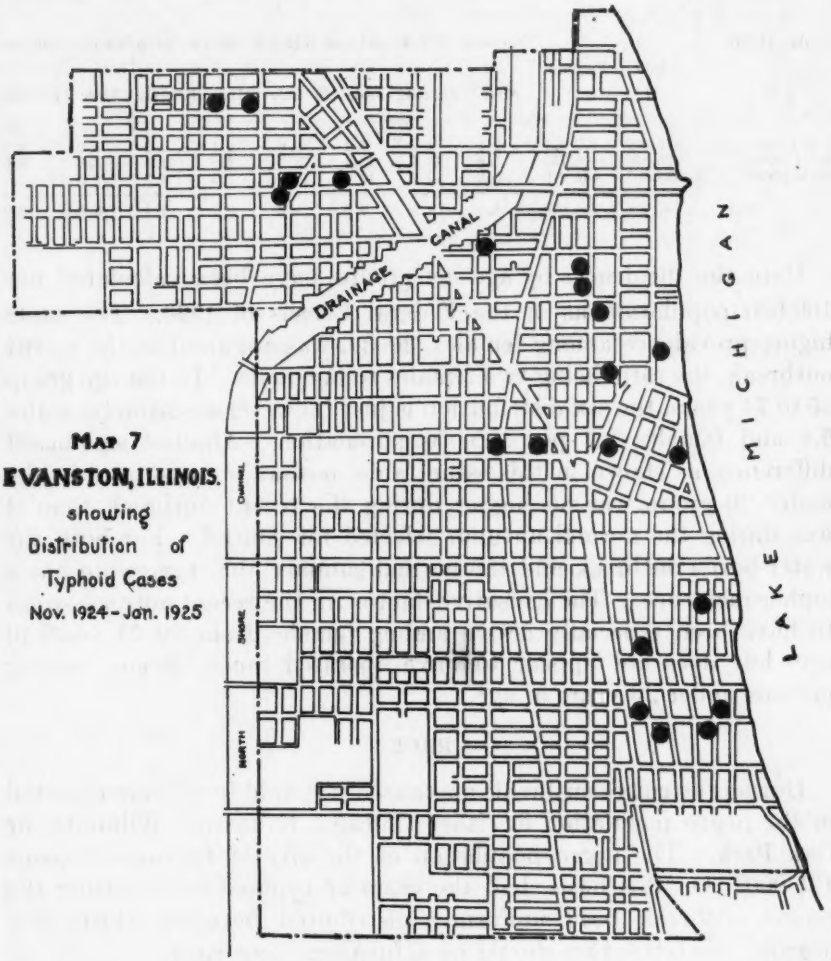
124 CASES

OYSTER BORNE INFECTION



87639—25t. (Face p. 36.)

and the normal autumn the cases among males represent 60 per cent or over of all the cases reported. In the water-borne outbreak the males are again slightly in excess, 52 per cent. The recent outbreak shows a very slight excess of females for all ages, about 51 per cent. Variations are much more striking when the age groups are studied separately. For persons under 20 years of age the incidence is greater among the males in all four periods. This preponderance



MAP 7
EVANSTON, ILLINOIS.
showing
Distribution of
Typhoid Cases
Nov. 1924 - Jan. 1925

among the males continues in all the age groups except the 20–34 age group, in which group the females are in excess both in the recent outbreak and the one of 1923. Infection among the females was twice as frequent in the 20–34 age group during the recent outbreak as among the males. In the water-borne outbreak the excess among the females for this age group was very slight.

37639—25†——4

That this difference in sex distribution is not due to a preponderance of females in the population for these age groups is shown in Table No. 10.

TABLE No. 10.—*Morbidity rate per 100,000 population for data reported in Table No. 9 based on the actual population in each age-sex group in Chicago as of the 1920 census*

Age groups	Population of 1920		Case rate per 100,000							
	Male	Female	Outbreak of 1924		Outbreak of 1923		Normal autumn		Normal summer	
			Male	Female	Male	Female	Male	Female	Male	Female
0–19 years	476,069	479,521	2.1	1.2	7.1	3.6	2.1	1.2	5.0	4.2
20–34 years	395,890	406,155	5.8	11.1	12.4	13.3	3.8	1.5	3.8	3.0
35–74 years	485,567	431,019	5.8	2.7	10.3	10.9	2.5	1.3	2.5	1.3
Total	1,357,526	1,316,695	4.5	4.8	9.5	9.0	2.7	1.4	3.8	2.6

Here the incidences by age-sex groups have been calculated per 100,000 population as of the Federal Census of 1920. The same higher prevalence among females, 20–34, was apparent in the recent outbreak, the ratio being two females to one male. In the age group 35 to 74 years, the sex distribution is just the reverse—namely, males 5.8 and females 2.7 per 100,000 population. Another significant difference, as shown in this same table, is that the case rate in the under 20 group was no higher during the recent outbreak than it was during the normal autumn selected for control. For both the water-borne outbreak and the normal summer this age group has a higher incidence. The causative factor in the recent outreak seems to have been especially active among females from 20–34 years of age, but does not appear to have operated much, if any, among persons under 20 years of age.

RACE

During the entire outbreak no cases of typhoid fever were reported in the negro population in either Chicago, Evanston, Wilmette, or Oak Park. The negro population of the city of Chicago is about 125,000. On this basis, had the cases of typhoid fever during the recent outbreak been uniformly distributed between whites and negroes, the latter race should have furnished five cases.

OCCUPATION

The distribution of cases by occupation is arranged in Table No. 11 into nine groups. The attempt has been made to place the occupations into similar groups on a basis of economic and social activity. Unfortunately, the housewife was recorded as such instead of by occupation of the husband. The social, economic status of a house-

wife, as well as the sanitary condition of the home, is very largely dependent upon the family income. From a personal knowledge of each case involved, it is known that all of the cases grouped under the title "not gainfully employed," actually belong in the first five groups of Table No. 11.

TABLE No. 11.—*Ninety-eight typhoid fever cases investigated in the Chicago district arranged into nine groups according to the occupation of those infected*

Occupation	Total	Per cent	Occupation	Total	Per cent
1. Professional	19	19.4	6. Farmer	1	1.0
2. Contractor and engineer	6	6.1	7. Skilled laborer	4	4.1
3. Real estate and insurance	2	2.0	8. Unskilled laborer	4	4.1
4. Clerical, stenographic, and salesman	23	23.4	9. Not gainfully employed [1]	31	31.7
5. Merchant	8	8.2	Total	98	100.0

[1] This includes persons at leisure, students, visitors, and "housewives."

According to the 1920 Federal Census of occupations in Chicago, slightly less than 6 per cent of the persons gainfully employed are classed as professional. As arranged in Table No. 11, 19.4 per cent are so employed with the further certainty that many of the cases in Group 9 actually belong with the professional group, thus further increasing the excessive prevalence of typhoid fever in this group. The proportion of cases occurring in the "clerical, stenographic, and salesman" group is also high. This group includes female stenographers and clerks; 11.3 per cent of the total cases occurred among females giving their occupation as stenographer or office clerk. The average age of females pursuing such occupations would easily fall within the age group 20–34 years. It was shown in Tables Nos. 9 and 10 that the typhoid fever incidence for females in this age group is far in excess of the male.

The classification of cases by occupation reveals two peculiar characteristics of the causative factor, or factors, in the recent excessive prevalence of typhoid fever. First, it has shown a higher attack rate among persons occupied in technical or highly skilled pursuits, and, secondly, that for any single occupation it was highest among female stenographers and office clerks.

STUDIES OF THE RECENT OUTBREAK

The Chicago outbreak has been carefully and extensively studied by the local city health department.[2] Similarly, the cases occurring in the three suburbs mentioned have been studied by both the health departments of these towns and also by representatives from the State

[2] Bundesen, Herman N. 1925. Typhoid epidemic in Chicago apparently due to oysters. Journal of American Medical Association. Vol. 84, No. 641.

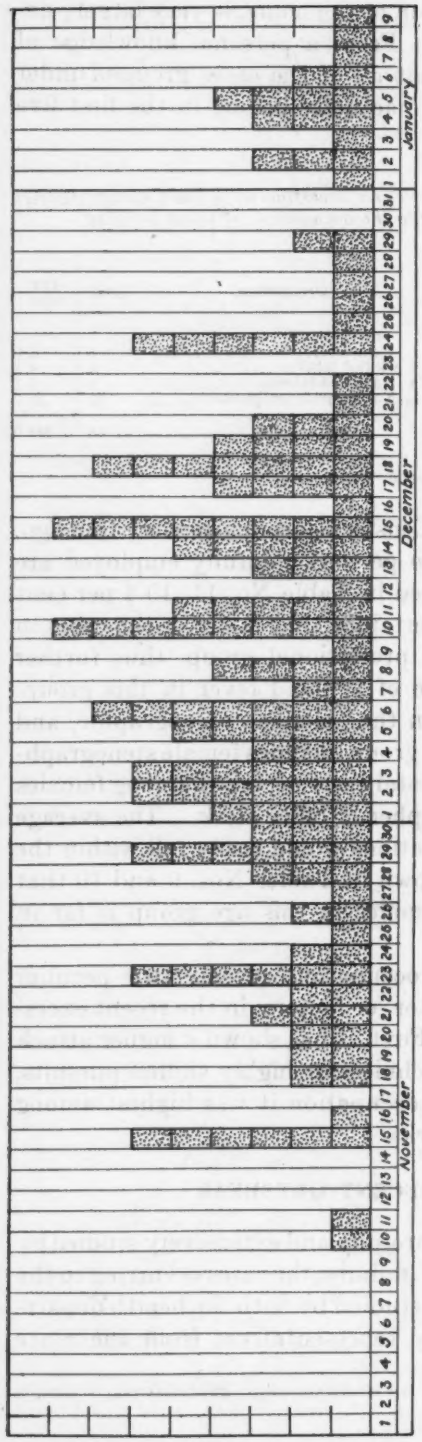


CHART NO. 3.—Total typhoid fever cases reported in Chicago, Evanston, Wilmette, and Oak Park, Ill., from Nov. 30, 1924, to Jan. 21, 1925 (recorded by date of going to bed)

Board of Health of Illinois. However, in order that the Public Health Service might obtain an entirely impartial and independently arrived at picture of the outbreak in these cities, it was deemed advisable that representatives of the Service should personally visit as many of the cases as time and condition of the patients would permit. Out of a grand total of 163 cases reported in the Chicago district, visits were made to 89 cases in Chicago and 29 cases in the suburbs. Twenty-one cases had died before the beginning of the investigation, so that no history of them could be obtained; 24 cases were not visited due to lack of time, 18 cases were visited, but for one reason or another the patient could not be seen, some being too ill, others having recovered and gone away to recuperate, etc. Thus 75 cases in Chicago and 25 cases in the suburbs, or 61.4 per cent of all the cases, were available for epidemiological histories. Two of the 100 were abandoned because the patients were too ill to corroborate accurately. Eight others gave complete histories, except with regard to the kinds of oysters eaten or the places of eating. There remain 90 cases whose epidemiological histories are regarded as accurate in every detail as far as the patient's memory would permit.

In obtaining the epidemiological histories a uniform case record form was used for each case. In each instance the patient was seen personally. In many instances the memory of the patient was assisted by that of the nurse or a relative. In a number of cases, access was also had to the hospital records, and in a few cases the family physician also assisted. No arbitrary selection of cases was made except possibly that a few cases were purposely omitted because they were more remotely situated. Reference to charts Nos. 3 and 4 will show that the distribution of cases studied is essentially the same as for all the cases.

Up until this time the cases occurring in Chicago and those occurring in the suburbs of Evanston, Wilmette, and Oak Park have been considered separately. In such discussion as follows, the cases will be

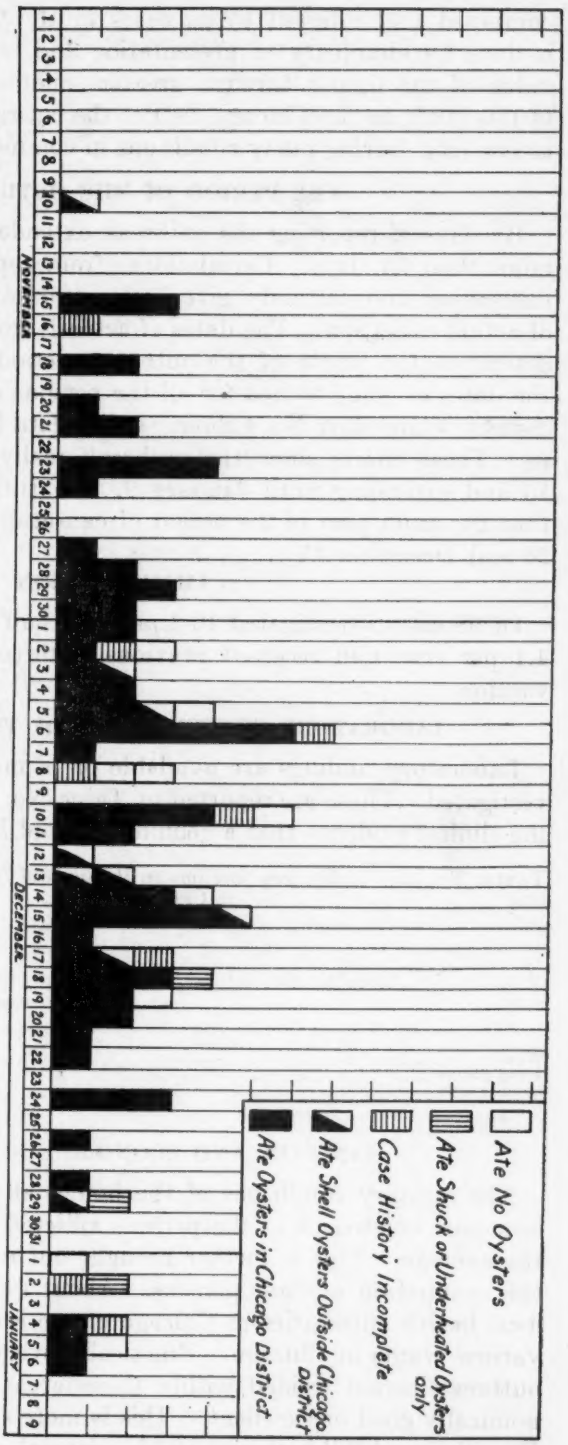


CHART No. 4.—Typhoid fever cases investigated by the United States Public Health Service in the Chicago district (recorded by date of going to bed)

combined and referred to as cases in the Chicago district. This is done for simplicity of presentation and in order to increase the value of the figures through greater numbers. For the purposes of this study in the Chicago district the entire area may be regarded as one city, having many conditions in common.

THE PERIOD OF THE OUTBREAK

By days of reporting the outbreak extended over a period of not more than 53 days. Calculations from reports of cases may be misleading and certainly give little information as to the period of actual causation. The dates of actually going to bed more nearly determine the length of the outbreak period. Chart No. 3 shows the dates of going to bed for all the persons affected in the Chicago district, while chart No. 4 shows similar data for the cases studied by us. These charts show the outbreak really beginning November 15 and extending until January 9. On this basis it is estimated that the main part of the period of causation was between October 26 and December 15.

IMMUNIZATION

Of 98 cases investigated 10.2 per cent had had typhoid fever and 4.1 per cent had received previously three injections of typhoid vaccine.

LABORATORY CONFIRMATION OF THE OUTBREAK

Laboratory findings are available on a majority of the cases investigated. These are reported in Table No. 12, in order to confirm the clinical evidence that a genuine typhoid fever outbreak did exist.

TABLE No. 12.—*Laboratory findings in the typhoid fever cases investigated in the Chicago district*

Laboratory test	Total cases	Laboratory findings			Per cent total cases reported positive
		Positive	Negative	No report	
Widal	98	87	1	10	88.7
Blood culture	98	8	1	89	8.2
Urine or feces	98	23	0	75	23.5

SANITARY AND ECONOMIC CONDITIONS

The sanitary conditions of the homes affected and the apparent economic conditions of the persons afflicted are considerably above the average. This is further brought out in Table No. 11 showing the occupation of these persons. About 1920 a study was made by local health authorities in Chicago of the economic condition of the various wards in Chicago. Practically every case within the recent outbreak period resided within those areas reported as being economically good or excellent. This is more strikingly brought out in Evanston and Wilmette, where the general economic average is con-

siderably above such average for the city of Chicago as a whole. Even here the cases are largely confined to the very best homes and in the choicest sections of the residential section. It is a very striking and significant fact that practically every case which occurred within the period of the outbreak, either possessed ample funds for good economic and sanitary surroundings or were very intimately associated with and under the influence of such conditions. The details of the sanitary and economic conditions of the persons affected are presented in detail in Tables Nos. 13 and 14, respectively.

TABLE No. 13.—*The general sanitary conditions of the homes of the persons affected.*

	Total	Per cent
Total homes involved	96	
Home condition:		
Excellent	35	36.5
Good	41	42.8
Fair or poor	5	5.2
Not stated	15	15.6

TABLE No. 14.—*The apparent economic conditions of the persons affected.*

	Total	Per cent
Total cases investigated	98	
Apparent economic condition:		
Excellent	31	31.7
Good	42	42.8
Fair or poor	9	9.2
Not stated	16	16.3

DRINKING WATER

Chicago's public drinking water supply is obtained from Lake Michigan through six cribs located at various distances out in the lake, from the Wilson crib near the north border of the city to the Dunne crib in the south. The water from these cribs is distributed by means of 12 sets of pumps located in as many pumping districts, Table No. 15. There is some intermixing of water at the periphery of these pumping districts, but in general each district has an independent supply. All the water is chlorinated. Records of the sanitary engineer's office show that at no time during the period of causation did the treated water fail to show residual chlorine. Similarly, only one test out of about 1,500 bacteriological tests showed more than 2 *B. coli* per 100 c. c. of water.

TABLE No. 15.—*Giving the names of the Chicago water intake cribs and the pumping districts which they supply*

Name of intake crib	Name of pumping district
Wilson crib	Mayfair, Lakeview.
Harrison crib	Chicago Avenue (partially), Central Park, North Springfield.
Two-mile crib	Chicago Avenue (partially), Twenty-second Street.
Four-mile crib	Fourteenth Street, Harrison Avenue.
Hyde Park crib	Sixty-eighth Street (1 pump).
Dunne crib	Sixty-eighth Street (3 pumps), Roseland, Washington Avenue (summer only).

The above evidence, along with the general features of the outbreak, seems to be ample to eliminate public drinking water. It will further be observed from Map 4 that the majority of cases are distributed over territory supplied by water from three widely separated intake cribs. In Evanston, where the case rate is much higher, the public drinking water used is independent of the Chicago supply and of excellent quality.

More than 80 per cent of the cases depended solely on municipal water supplies for their drinking water. Less than 2 per cent reported that they drank bottled water exclusively, while slightly less than 20 per cent drank bottled water occasionally. The bottled waters used came from three or four different sources. Very few cases reported the use of ice directly in their drinking water.

MEALS, WHERE TAKEN

Each one of the persons investigated reported having dined at some public eating place at least once within the possible incubation period. The cases occurred among persons who dine out, either altogether, or who are in the habit of eating at popular and high-class restaurants from time to time, frequenters of exclusive clubs or restaurants, hotels where people go for eating and dancing, restaurants which are noted for good food, or cabarets. In other words, the cases occurred among that group of people who eat what and where they wish. Not a single eating establishment of such character in the Chicago district escaped having at least one case of typhoid fever reporting as having eaten there during the possible incubation period. A number of the affected persons ate in hotels of eastern cities, but in each of such instances the person was potentially exposed to at least one factor common to the restaurants of the Chicago district.

DAIRY PRODUCTS

A majority of the persons affected were not in the habit of using milk as a beverage; 42.3 per cent of the persons affected (Table No. 16) reported using milk as a beverage at least once during the possible incubation period, and 9.3 per cent said they used cream on cereal or desserts but not as a beverage. The home milk supply of 93 persons affected was traced to 22 different public milk supplies, all of which produced pasteurized milk. Nine of these dairies had a total of 80 cases among their patrons. Calculated on the basis of daily milk sales, these nine dairies averaged 1,600 gallons of milk sold per case of typhoid fever among their patrons. The maximum was 2,200 gallons per case, and the minimum 700 gallons.

TABLE No. 16.—*The consumption of dairy products by persons affected*

	Number	Per cent
Total cases investigated	97	
Milk or cream:		
Used as a beverage	41	42.3
Used on cereals, etc.; not as a beverage	9	9.3
Used in coffee or tea only	29	29.8
Use not stated	18	18.6
Ice cream	67	69.0
Cheese consumption:		
American Cream	22	22.7
Cottage	12	12.4
Roequefort	9	9.3
Cammenbert	5	5.1
Swiss	5	5.1
Kraft	3	3.1
Pimento	2	2.0
Kind eaten not stated	10	10.3
No cheese eaten	51	52.6

A history of butter eating was given by all the persons having typhoid fever. There was a rather uniform distribution of cases to brands of butter sold in the Chicago district.

Ice cream was eaten once or more (Table No. 16) by 69 per cent of the persons affected. The kinds of ice cream eaten traced back to essentially every producer of ice cream in the Chicago district. The persons affected are not limited to persons who are either frequent eaters of ice cream, or who ate only one make.

Cheese could not have been an important factor. Only 47.4 per cent of the persons affected (Table No. 16) had eaten cheese of some kind at least once during the possible causative period; some had eaten more than one kind. At least seven different makes of cheese are included in the histories.

The absence of any excess of cases among young children is strong evidence to show that dairy products could not have been an appreciable factor in the spread of typhoid fever in the recent outbreak. Three cases, or 2.3 per cent, were reported in children under 10 years of age, whereas the normal under 10 for this season of the year is about 7 per cent.

RAW VEGETABLES

The eating of certain raw vegetables has become a very common and frequent practice. Methods of farming raw vegetables, in some instances, make them a potential source of typhoid fever infection. There is presented in Table No. 17 a list of the vegetables which are regarded as such potential factors. It is seen from this table that all but two of the vegetables may be eliminated at once, because their consumption was not sufficiently widespread. Lettuce and celery were eaten by a large majority of the cases and, therefore, each must be considered as a possible major causative factor.

TABLE NO. 17.—*The amount and kind of raw vegetables consumed by the persons affected*

	Number	Per cent		Number	Per cent
Total cases investigated	97		Cabbage	17	17.6
			Radishes	7	7.2
Lettuce	86	88.7	Water cress	7	7.2
Celery	86	88.7	Onions	8	8.3
Endive	2	2.1	Tomatoes	12	12.4
Romaine	0	0.0			

Two possible methods may be employed for weighing the value of either as a factor. One method is to undertake to trace the vegetable back to the source of production to ascertain if a majority of the afflicted persons ate a vegetable coming from a common source. This was found to be attended with great difficulties in Chicago because of the numerous dealers or shippers involved between initial producer and consumer. The second method is to ascertain the raw vegetable eating habits of a comparable group of persons who did not contract the disease. Should the consumption of celery or lettuce be correspondingly high among the control group the possibility of each of these vegetables being a major factor is greatly lessened. Use was made of both methods in studying the outbreak in the Chicago district.

It was not possible to take the individual person affected and trace back the lettuce or celery eaten to the initial producer. The eating of these vegetables was such a frequent practice, and the retail purchases were so varied, that scores of dealers became involved long before the producer was reached. The result was a hopeless network of entwined paths. The solution of the problem was therefore attempted through four restaurants in Chicago, at one or the other of which a total of 25 affected persons stated they had eaten at least once. A three-week period, October 27 to November 15, 1924, was studied because a majority of the persons affected must have received their infection within that time. The causative factor most certainly was active during this time.

The investigation was conducted through, and with the aid of, the food division of the city health department. Personal calls were made first on the hotels and then on through the various Chicago dealers until shipping bills were found showing from what territory the particular lot of vegetable in question came. The search was carefully conducted, and the information is believed to be accurate, since in most instances the dealers' shipping bills or books were inspected.

In diagram No. 2 there is shown the source of celery received by the four restaurants in question. The designations "Chicago A," etc., refer to local dealers, while the source of production and the initial shippers of celery are referred to by a letter and the name of a

State. This chart carries the celery back to the initial shipper in the producing area. There was no common source of supply for all the four restaurants. In fact, the same supply reached no more than two of the four restaurants, and in these two restaurants the common supply constituted only a small portion of the total supply. The majority of Chicago's celery supply came from Michigan and only a

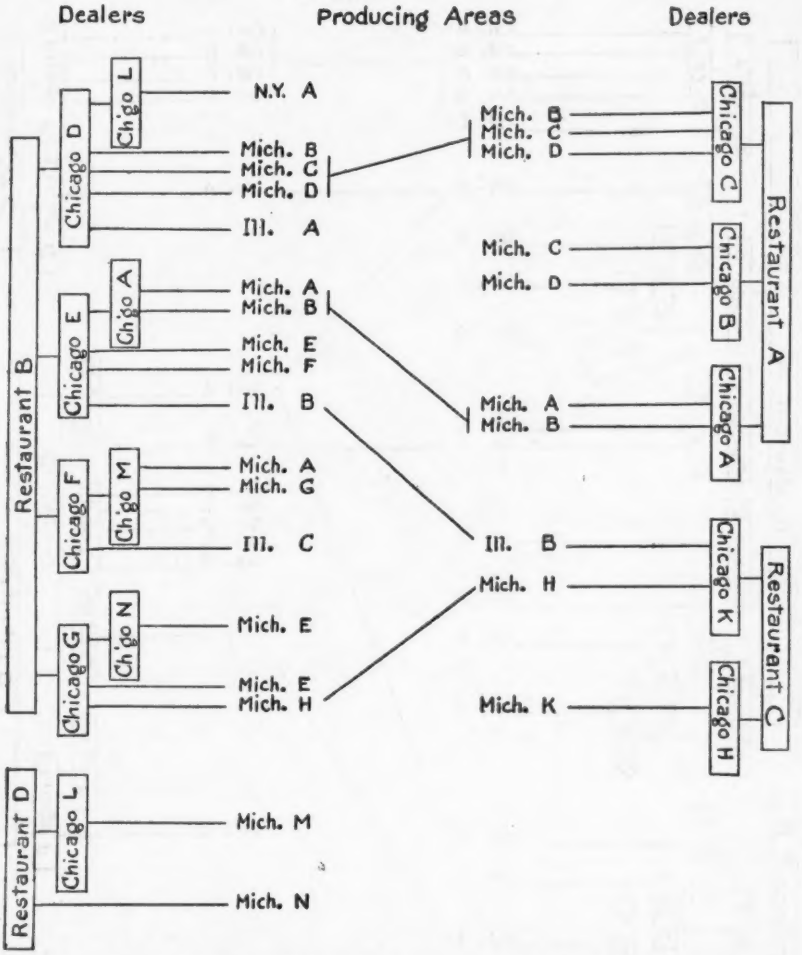


DIAGRAM NO. 2.—Showing the producing area of the celery purchased by four Chicago restaurants from Oct. 27 to Nov. 15, 1924, and the intermediate dealers involved

portion of one dealer's supply came from the State of New York. None was received from California during this time.

A similar investigation was made into the lettuce served by these four restaurants. The method of handling lettuce is even more complex than is the celery situation. The selling and reselling to various dealers, commission men, or speculators, seem almost endless before the lettuce reaches the individual family. However, by starting

the investigation with the large restaurants, it was possible to eliminate some of the confusion. Diagram No. 3 shows the sources of all the lettuce reaching these four restaurants within the three weeks selected. Lettuce grown in the State of Idaho found its way to the patrons of all four restaurants. This is the only supply common to all four

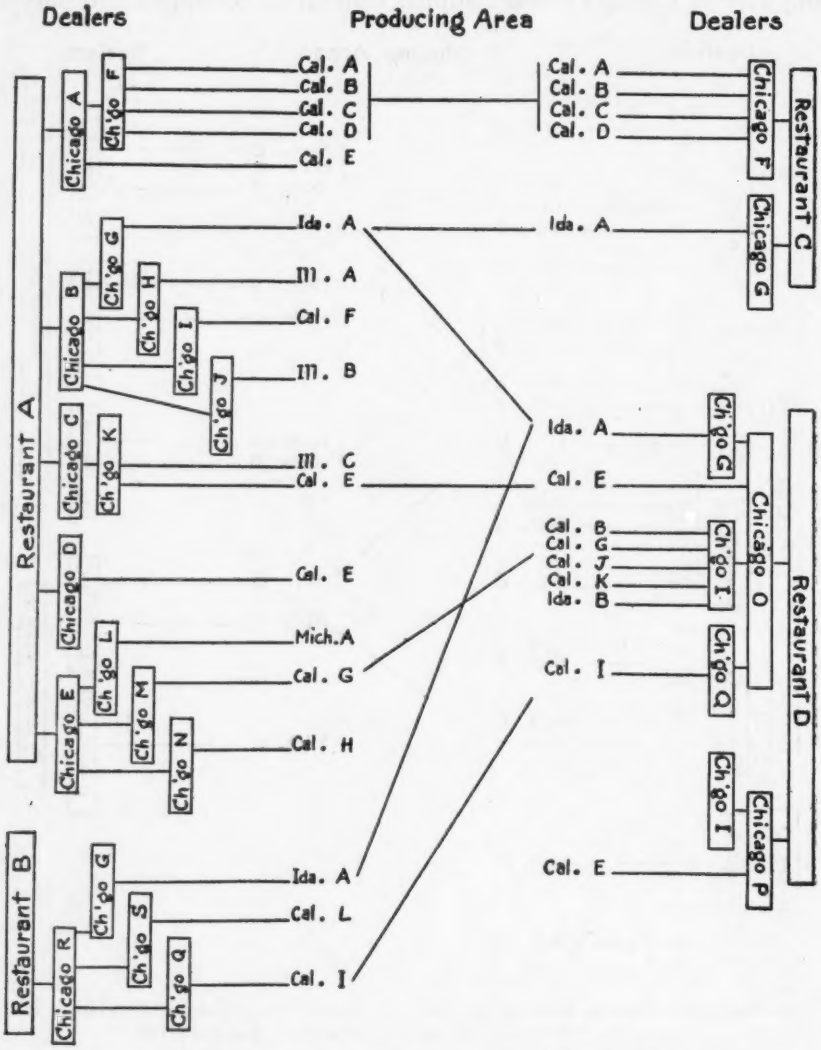


DIAGRAM NO. 3.—Showing the producing area of the lettuce purchased by four Chicago restaurants from Oct. 27 to Nov. 15, 1924, and the intermediate dealers involved

restaurants, but it represents only a portion of each restaurant's entire supply. There are other points of contact common only to two restaurants.

The evidence obtained by the above investigations, and presented in diagrams Nos. 2 and 3, is rather conclusive. The wide geographic

distribution, and the multiplicity of each restaurant's supply, coupled with the relatively small common supply going to two or more restaurants, cause both celery and lettuce to become apparently improbable factors in the outbreak. Evidence will be presented in Section VI of this report from data supplied by the United States Department of Agriculture, which will show that all of the celery, and at least a large part of the lettuce, supplied to Chicago markets during this time was entirely independent of corresponding supplies of these two vegetables going to certain other cities of the United States which had at this same time excessive prevalences of typhoid fever. Evidence will also be given to show that the consumption of celery and lettuce was equally as frequent among the uninfected portion of the population.

OYSTERS

The consumption of raw shell oysters by the persons becoming ill with typhoid fever was vastly more frequent than among the population as a whole. Ninety of the ninety-eight cases investigated were in persons able to give definite information regarding their oyster-eating habits over a period of 30 days prior to going to bed. Detailed analyses of these 90 cases are presented in Tables Nos. 18, 19, and 20.

TABLE NO. 18.—*Showing the extent of oyster eating among persons furnishing the typhoid fever cases investigated during the November 30 to January 21 outbreak*

Oyster-eating history	Total	Per cent
Total cases giving complete histories	90	
Kind of raw shell oysters eaten:		
Bluepoint	73	81.1
Rockaway	1	1.1
Cotuit	8	8.8
Sea Tag	1	1.1
Lynnhaven	2	2.2
Uncertain kinds	2	2.2
Total individuals having eaten—		
Raw shell oysters	76	84.4
Raw shucked oysters	10	11.1
Raw shucked oysters only	2	2.2
Heated oysters	12	13.3
Heated oysters only	1	1.1

The eating of raw shucked oysters or heated oysters may be disregarded since the number of cases exposed to these exclusively is too small to be significant. Therefore, only raw oysters eaten on the half shell are further considered in this section of this report.

TABLE No. 19.—*Giving the total cases of typhoid fever in the Chicago district and their relation to the consumption of oysters*

	Chicago	Suburbs	Chicago district
Total cases during the recent excessive prevalence	129	34	163
Cases in persons who died; no records obtained	16	5	21
Cases in persons who were not visited	113	29	142
	24	0	24
Cases in persons visited but no records obtained	89	29	118
	14	4	18
Cases in persons visited and records obtained	75	25	100
Cases in persons giving incomplete histories	7	3	10
Cases in persons giving complete histories	68	22	90
Cases in persons infected out of town and who did not eat oysters	3	0	3
Cases in persons potentially exposed to company A shell oysters away from Chicago only	65	22	87
	4	1	5
Cases in persons potentially exposed to other shell oysters away from Chicago district	61	21	82
	2	0	2
Cases in persons most likely infected in the Chicago district	59	21	80
Cases in persons infected in Chicago district and who did not eat oysters	5	1	6
Cases in persons who were most likely contact of other outbreak case	54	20	74
	0	1	1
Cases in persons who ate oysters in some form during incubation period	54	19	73
Cases in persons who ate only heated oysters	1	0	1
Cases in persons who ate only raw shucked oysters	53	19	72
	2	1	3
Cases in persons who ate raw shell oysters in the Chicago district	51	18	69

Table No. 19 indicates why only 100 of the 163 cases in the Chicago district were covered by our intensive epidemiological study. Of these 100 cases, 90 gave definite histories with respect to oyster eating. Further elimination of 3 cases in persons who certainly received their infection away from the Chicago district, but who did not eat oysters, and of 7 cases in persons who ate shell oysters exclusively away from the Chicago district, leaves a group of 80 cases in persons who certainly received their infection in the Chicago district. Sixty-nine of these cases, Table No. 19, gave definite history of having eaten raw oysters on the half shell within the possible incubation period.

The shell oyster eating habits of this group of 80 persons are given in detail in Table No. 20. Sixty-nine, or 86.2 per cent, ate raw oysters on the half shell. These 69 were potentially exposed to oysters produced in one or more of four different oyster-producing areas of the Atlantic coast. The potential exposures to each of three of these sources are so low as to be insignificant. Two producing companies shipped shell oysters coming into the Chicago district from the fourth producing area which is in, or within the immediate vicinity of, Great South Bay, N. Y. Oysters coming from both of these companies are offered to the trade under the name of "Blue-

point" oysters. These two companies shipped into the Chicago district essentially the same number of shell oysters, Table No. 21, yet it will be seen from Table No. 20 that 66 cases, or 82.5 per cent, were potentially exposed to company A oysters, whereas only 12, or 15 per cent, were potentially exposed to company D oysters. These figures are extremely significant. If the cases are studied on the basis of exclusive exposure to one brand of oyster, the selective action exercised by Bluepoint oysters from company A is even more striking. Forty-nine, or 60.1 per cent, of the cases were exposed exclusively to company A oysters as compared to only one case, or 1.2 per cent, to company D oysters.

TABLE NO. 20.—*Showing the cases of typhoid fever infected in the Chicago district and their relation to raw shell oyster consumption*

	Cases in Chicago district	Per cent
Cases in persons most likely infected in the Chicago district	80	
Cases in persons who ate raw shell oysters in the Chicago district	69	86.2
Cases in persons potentially exposed to—		
Lynnhaven oysters	1	1.2
Sea Tag oysters	1	1.2
Cotuit oysters	6	7.5
Company D Bluepoint oysters	12	15.0
Cases in persons potentially exposed to company A Bluepoint oysters	66	82.5
Cases in persons exclusively exposed to—		
Lynnhaven oysters	0	0.0
Sea Tag oysters	0	0.0
Cotuit oysters	2	2.5
Company D Bluepoint oysters	1	1.2
Cases in persons exclusively exposed to company A Bluepoint oysters	49	60.1

TABLE NO. 21.—*The number of barrels of shell oysters shipped into and consumed in the Chicago district from September 1, 1924, to December 31, 1924, inclusive*

	Number of barrels shipped into Chicago district	Number of barrels consumed in Chicago district	Estimated number of oysters consumed in Chicago district
Bluepoint oysters from company A	1,720	1,654.1	2,315,740
Bluepoint oysters from company D	1,961	1,518.1	2,125,340
Bluepoint oysters from other sources	32	23.5	32,900
Sea Tag oysters	55	51.5	51,500
Cotuit oysters	565	509.4	509,400
Lynnhaven oysters	40	36.0	21,600
Total of all shell oysters	4,373	3,792.6	5,056,480

Seventy-three of the 76 persons potentially exposed to raw shell oysters in the Chicago district or elsewhere, Table No. 18, ate them exclusively in restaurants, 2 in both restaurant and home, and 1 exclusively at home.

On questioning the individuals affected with regard to the kinds of oysters ordered at the various restaurants, the reply in the majority of cases was that they had either ordered from the menu, oysters on the half-shell designated as "Bluepoints" or that they had simply

ordered Bluepoint oysters. Very few were sufficiently well acquainted with the physical characteristics of a genuine Bluepoint to state whether or not they had received such oysters. When questioned with regard to the size of the oysters eaten, the reply invariably was that they were small oysters. From information supplied by the oyster dealers in Chicago it is known that nearly all of the small oysters sold in the Chicago district come either from companies A or D and are regarded as Bluepoints. This excess of small-oyster consumption among the persons affected may explain why out of a total of 69 cases among persons who ate raw shell oysters, 39 were females and 30 males. It is a matter of common knowledge that women prefer small oysters.

The sources of the shell oysters served by the restaurants in the Chicago district can readily be traced to the initial producing company on the Atlantic seaboard. Almost all of the raw shell oysters consumed in the Chicago district are distributed by five wholesale dealers in Chicago, and the most complete and whole-hearted cooperation of these local dealers rendered the definite tracing of the oysters to the initial shipper both easy and accurate. Their shipping bills were examined, and these were in turn checked, so far as was possible, against the shipments by the producing companies without any appreciable discrepancies being found. It is therefore felt that the data presented in Table 21 are correct. This table shows that Bluepoint shell oysters consumed in the Chicago district came from company A and company D in about the same proportion. Table 20 shows that 82.5 per cent of the cases were potentially and 60.1 per cent were exclusively exposed to Bluepoint shell oysters from company A. The result is that Bluepoint shell oysters from company A remain as the only possible major causative factor among the various supplies of oysters shipped to Chicago.

The shell oyster data given in Table 21 extend over a period of 92 days—September 1 to December 31, 1924, inclusive. The number of oysters per barrel runs rather uniform for the different kinds—namely, 1,400–1,500 Bluepoints, 1,000 Cotuits, 1,000 Sea Tags, and 600 Lynnhavens per barrel. On this basis, it is estimated that 5,056,480 shell oysters were consumed in the Chicago district in this four-month period. From earlier discussions and tables presented in this section of this report, it seems probable that an infection period of 30 days for the Chicago outbreak would include a large majority of the cases. Therefore it is estimated that 1,648,860 shell oysters of all kinds, or 755,130 Bluepoint oysters from company A, were eaten in the Chicago district within the possible causative period. It is further estimated that each member of the oyster-eating public would eat on the average three servings of shell oysters, or 18 oysters, within such a period. On this basis, 91,603 people ate shell oysters of all

kinds, or 41,952 ate Bluepoint shell oysters within the possible causative period of the outbreak. This number of people represents 3 per cent and 1.4 per cent, respectively, of the entire estimated population of the Chicago district. It has been shown in Table 20 that 86.2 per cent of the cases investigated were exposed to shell oysters of some kind and that 82.5 per cent were potentially exposed to shell oysters coming from company A. Therefore the persons exposed to company A oysters, and composing only 1.4 per cent of the total population of the Chicago district, furnished 82.5 per cent of all the typhoid-fever cases.

The gross number of cases reported in the city of Chicago within the outbreak period was 129. About 33, or 25 per cent, can be explained on the basis of normal expectancy for this period; 82.5 per cent of the cases are accounted for in Table 20, leaving only 17.5 per cent of the cases certainly receiving their infection in Chicago to be explained on some other hypothesis than raw Bluepoint shell oysters shipped to Chicago by producing company A.

The conclusion that the Bluepoint oysters from company A were the major causative factor is further strengthened by histories of certain groups of cases occurring in the Chicago district. Case 3S was that of a young woman student at Northwestern University in Evanston. She had lived continuously for several months at one of the girls' dormitories and had eaten practically all of her meals at the dormitory dining room, which is regularly patronized by a large number of university students, both men and women. On November 1, her older married sister and the latter's husband came from their home in Lafayette, Ind., to Chicago. The brother-in-law attended to business in Chicago while the wife went to Evanston to visit her sister. The two sisters had lunch in Evanston eating at a select lunch and ice cream parlor in Evanston patronized largely by college students. They had no food in common except cream of tomato soup, rolls, and butter. Later in the day they went into Chicago to spend the evening. They had their evening meal at a very popular restaurant. They both had six small oysters on the half shell, which they ordered by the name of Bluepoints and which appeared on the menu as such. Nothing else was eaten in common except the coffee they had to drink. That evening the older sister rejoined her husband and the other returned to Evanston. The next morning the former two returned to Lafayette, Ind. On November 12, the sister in Lafayette commenced to feel ill, and on November 23 the Evanston sister complained of illness. The former went to bed on November 16 and her case was diagnosed typhoid fever. The latter went to bed on November 24, her case also being diagnosed typhoid fever. The oysters eaten were traced to a Chicago dealer who in turn bought direct from company A.

Another instance is cited. On November 30, a family of four adults living in a very excellent section of Chicago went by automobile to Joliet, Ill. They had dinner there and then returned to Chicago. All ate the same kind of food except that three had Bluepoints on the half shell, and, because the restaurant had no more oysters, the fourth member of the party had soup instead. Twenty-four days later two members of the party who had eaten oysters went to bed with what was later diagnosed typhoid fever. The oysters eaten were purchased by this restaurant from a dealer in Chicago, who in turn purchased direct from company A.

Having reached a conclusion as to the major causative factor, it is interesting to consider the incubation period of the cases involved in the outbreak. A considerable number of the cases were in persons who were exposed only once to Bluepoint shell oysters from company A and who were able to give accurate dates regarding these exposures. The period of time intervening between ingestion of the oysters and date of going to bed is significant. Table No. 22 gives the minimum, maximum, and average incubation periods as based on the oyster-eating history. Table No. 23 gives similar information relative to five cases in persons who had previously been immunized. The data in these two tables confirm the professional opinion with regard to the length of incubation periods, and the reaction of different persons to infection. It also gives valuable information relative to the length of the incubation periods, and their wide range, in an outbreak caused by infected oysters. Four other persons reported that they had previously had the disease. These cases all had mild attacks during the recent outbreak. Since they had had several exposures to Bluepoint oysters from company A, their incubation periods could not be determined on the oyster-eating basis.

TABLE No. 22.—*Estimated incubation period for typhoid fever as determined from the cases having only one exposure to the major causative factor*

	Character of the disease			All cases
	Severe	Medium	Mild	
Total cases of typhoid fever	9	4	9	22
Average days of incubation	15.1	18.7	21.3	18.3
Minimum days of incubation	5	15	15	5
Maximum days of incubation	24	27	33	33

TABLE No. 23.—*Estimated incubation period for typhoid fever as determined from cases in persons previously immunized against typhoid fever and having only one exposure to the major causative factor*

	Character of the disease			All cases
	Severe	Medium	Mild	
Total cases of typhoid fever	0	0	5	5
Average days of incubation				29
Minimum days of incubation				19
Maximum days of incubation				41

CLAMS

In the period September 1 to December 31, inclusive, there were shipped into the Chicago district 2,270,700 shell clams of all kinds. The receipts were uniformly distributed over the 92 days. Cherry Stones and Little Necks constitute 1,160,200 of these clams. It is assumed that two-thirds of the Cherry Stones and Little Necks were eaten on the half shell. Such an estimate is corroborated by both dealers and restaurant proprietors. Therefore, during the estimated causative period 252,200 clams were consumed on the shell as compared to 1,648,860 shell oysters of all kinds, or 755,130 shell oysters from company A.

Of the 90 cases studied, only one had been potentially exposed to raw clams in the Chicago district. This ratio of cases potentially exposed to raw shell oysters of all kinds to cases exposed to raw shell clams is therefore 69 to 1, whereas the ratio of such oysters to clams consumed is only 6.6 to 1. Since company A raw shell oysters are considered the major causative factor, it is interesting to see what ratio these hold to raw clams. The estimated consumption of Bluepoint shell oysters from company A for the estimated probable infection period is 755,130 against 252,200 clams. This is a ratio of 3 to 1. The numbers of cases occurring among persons exposed to these two possible carriers of infection represent a ratio of 66 to 1.

The consumers of raw shell oysters and raw shell clams are people whose social, economic, and eating habits are practically identical. Both foods may be regarded as a luxury. They are almost exclusively eaten by persons dining in high-class restaurants where quality and variety are the requirements rather than the cost of the meal. The choice of either shellfish is based solely on the peculiar tastes of the individual; but usually the two foods are eaten by different persons. Therefore it would appear entirely unreasonable to attempt to attribute to coincidence, instead of to cause and effect, such a difference of ratio, as 66 to 1, between two groups of persons who are so similar in every respect except their shellfish-eating habits.

A STUDY OF THREE CONTROL GROUPS

The determination of the eating habits of the general population of a community would obviously aid in ascertaining the various possible causative factors involved. Such a study was made in Chicago with the assistance of eight nurses detailed from the city health department.

Eight city blocks were studied. Four blocks were selected within the area of the recent outbreak and comprise homes, on the average, fairly comparable in sanitary and economic conditions, to those in which the typhoid fever cases occurred. Three blocks are on the

north side and one on the south. Persons studied in these blocks will be referred to as Group I. Two other blocks, one north and one south, were selected outside of the outbreak zone, but in sections of the city which were shown by the health department economic survey of about 1920 to have good economic conditions. Persons interviewed in these blocks will be referred to as Group II. Another set of two blocks was selected in sections of the city which were shown by the health department survey to live under fair or poor economic conditions. This constitutes Group III.

The study was conducted as nearly as possible along the same lines as the study of the cases. Epidemiological forms were prepared and the eight nurses were carefully instructed in how to use them. Visits were begun at one corner of the block and continued systematically around the block until the desired number of records was obtained. Only persons over 15 years of age were taken and records were obtained only by direct interview with each individual, the nurses working in the evenings in order to find the maximum number of people at home. If it appeared to the nurse that the informant was either uncertain or did not show a willingess to cooperate, she discarded the history. Records of eating habits during the month of November, 1924, only, were obtained since the majority of the persons were infected during this time. It is appreciated that such a survey can not be absolutely accurate. Errors will creep in on both sides of the truth, but the general average will be very representative of the true conditions. It is felt that the nurses did conduct the interviews in a thorough manner. The epidemiological histories obtained on the typhoid cases serve as a good check on the accuracy of the control investigation, since it is to be expected that at least the persons in control Group I will be very similar in most of their habits to the persons affected.

The salient facts obtained in this survey are recorded in Tables 24 and 25. Referring back to Tables 13 and 14, it will be seen that the sanitary conditions of the home, the apparent economic conditions of the individual, the history of previous attack of typhoid fever or immunization, and the eating habits of the persons having typhoid fever, and those who did not, are as applied to control Group I essentially the same except in their shell oyster-eating habits. The consumption rate of celery and lettuce among all three control groups is very significant, and furnishes striking evidence for the elimination of both of these vegetables as important factors in the spread of the infection. The sanitary and economic conditions among the cases and persons in control Group I are essentially the same. Variations occurring in Groups II and III are to be expected.

TABLE No. 24.—*The consumption of shellfish, raw vegetables, and dairy products by persons in three control groups; arranged according to economic conditions*

	Group I		Group II		Group III	
	Total persons	Per cent	Total persons	Per cent	Total persons	Per cent
Total persons interviewed	397		220		270	
1. Shellfish:						
Shell oysters, all kinds	22	5.5	2	0.9	1	0.4
Bluepoint shell oysters	19	4.8	0	0.0	1	0.4
Raw shucked oysters	27	6.8	25	11.8	13	4.8
Heated oysters	60	15.1	38	17.3	4	1.5
Raw clams	2	1.0	0		0	
2. Raw vegetables:						
Celery	371	94.4	198	90.0	225	83.5
Lettuce	375	94.5	197	89.5	205	76.0
3. Dairy products:						
Milk as a beverage	177	44.6	150	68.9	178	66.0
Ice cream	266	67.0	173	79.4	166	61.5

TABLE No. 25.—*Sanitary conditions of the homes, the apparent economic conditions, and the previous typhoid fever histories of persons living in three control groups; groups arranged according to economic conditions*

	Group I		Group II		Group III	
	Total persons	Per cent	Total persons	Per cent	Total persons	Per cent
Total persons interviewed	397		220		270	
Male	172	43.4	101	45.9	135	50.0
Female	225	56.6	119	54.1	135	50.0
General sanitary condition of home:						
Excellent	85	21.5	0		0	
Good	312	78.5	210	95.5	104	38.5
Fair or poor	0		10	4.5	166	61.5
Apparent economic condition:						
Excellent	83	20.9	0		0	
Good	308	77.6	138	62.8	75	27.7
Fair or poor	6	1.5	65	29.5	195	72.3
Not stated	0		17	7.7	0	
Typhoid fever history:						
Previous attack	41	10.6	15	6.8	13	5.0
Previously immunized	30	7.7	13	5.9	14	5.2

SUMMARY

Beginning on November 30, 1924, and extending over a period of 53 days, there were reported 129 cases of typhoid fever in Chicago, 21 in Evanston, 4 in Wilmette, and 9 in Oak Park, which number was approximately 125 in excess of the expectancy.

The geographic distribution, the excellent sanitary conditions of the homes affected, the good economic conditions of the persons affected, and their eating habits, all point very conclusively to some source of infection common to only a small portion of the entire population.

An analysis of the age-sex distribution shows no excess prevalence among persons under 20, but shows a marked excess among females 20–34 years old.

There were no cases in the negro population, whereas on the ratio of cases in the white population, negroes should have furnished at least five cases.

A careful analysis of the data collected shows that neither drinking water nor dairy products could have had an important or appreciable part in the spread of the infection.

Carriers are eliminated because of the large territory involved and the absence of any common contact in any considerable proportion of the persons affected.

Celery and lettuce are eliminated as vectors because of the absence of any evidence of a supply common to any large number of cases, and also because the use of these two vegetables was equally frequent in the unaffected population.

Of 90 cases giving complete oyster histories, 3 were out-of-town infections and were in persons who did not eat oysters, 7 were in persons who ate raw shell oysters away from the Chicago district, 11 were infected in the Chicago district but were in persons who did not eat shell oysters, and the remaining 69 cases were infected in the Chicago district and were exposed to the eating of raw shell oysters. Of the 80 cases infected in the Chicago district 66, or 82.5 per cent, were potentially exposed to Bluepoint oysters on the half-shell coming from company A, and 60.1 per cent were exclusively exposed to such oysters. Only 15 per cent were potentially exposed to company D oysters, the next most frequent source of shell oysters, while only 1.2 per cent were exclusively exposed to this company's oysters. Estimated on the basis of the total shell oysters from company A consumed during the probable period of infection, 82.5 per cent of the cases occurred in persons who were exposed to company A oysters and who composed only 1.4 per cent of the total population of the Chicago district. Whereas all but 17.5 per cent of the cases are definitely attributable to infection conveyed by raw shell oysters from company A, actually 25 per cent of the total cases occurring would have furnished only the normal expectancy rate and might have been attributed to the usual prosodemic factors.

CONCLUSION

All of the cases of typhoid fever occurring in Chicago, Evanston, Wilmette, and Oak Park in excess of the normal expectancy received their infection through eating raw Bluepoint shell oysters shipped into the Chicago district by a producing company operating in the vicinity of West Sayville, N. Y., and designated in the different sections of this report as company A.

Section IV

THE OUTBREAK IN NEW YORK CITY

During the period November 1, 1924, to February 14, 1925, 913 cases of typhoid fever were reported in New York City. Table No. 26 and chart No. 5 show the cases and deaths reported, by weeks, together with the expected number of cases based upon the record of previous years.

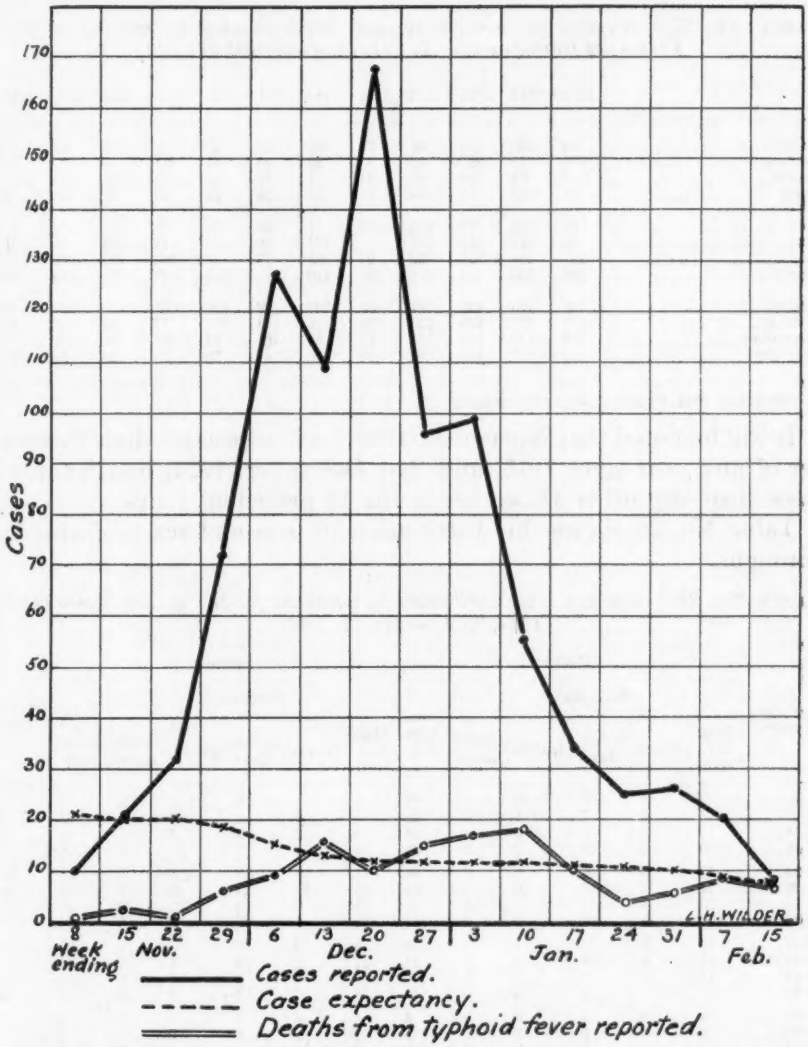


CHART No. 5.—Showing cases of typhoid fever reported, case expectancy, and deaths from typhoid fever reported, New York City, Nov. 1, 1924, to Feb. 14, 1925

TABLE No. 26.—*Typhoid fever reported in New York City, November 1, 1924, to February 14, 1925*

Week ending—	Case expectancy	Cases reported	Deaths reported	Week ending—	Case expectancy	Cases reported	Deaths reported
1924				1925			
Nov. 8	21	10	1	Jan. 3	12	99	17
15	20	21	2	10	12	66	18
22	20	32	1	17	11	34	11
29	18	72	6	24	11	25	4
Dec. 6	15	127	9	31	10	26	6
13	13	109	16	Feb. 7	9	20	9
20	12	168	10	14	8	8	7
27	12	96	15	Total for period	204	913	132

TABLE No. 27.—*Number of cases of typhoid fever reported by months in New York City from January 1, 1913, to December 31, 1924*

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924
January	79	100	107	66	79	30	36	47	39	19	64	58
February	78	75	281	63	98	28	20	14	21	8	22	36
March	65	64	90	66	43	35	17	25	38	21	29	48
April	67	127	81	86	61	53	28	26	42	22	42	41
May	92	108	74	116	106	51	32	29	35	33	37	60
June	86	147	117	115	115	164	39	51	42	50	55	161
July	137	200	191	132	93	268	77	78	103	97	55	168
August	229	303	509	258	185	110	115	199	173	159	180	163
September	728	470	423	281	365	209	199	196	237	137	205	146
October	631	337	429	223	178	125	144	142	77	104	95	100
November	289	170	184	133	87	52	106	92	67	91	57	142
December	162	159	167	90	63	66	41	70	25	49	49	[1] 617

[1] December, 1924, figures subject to correction.

It will be noted that November, 1924, had more cases than November of any year since 1915, and that December, 1924, had far more cases than any other December in the 11 preceding years.

Table No. 28 shows the distribution by age and sex and also by boroughs.

TABLE No. 28.—*Age and sex distribution by boroughs for the period November 1, 1924, to January 11, 1925*

Age group (years)	Males						Females						Grand tota
	Borough					Total males, city	Borough					Total females, city	
	Manhattan	Bronx	Brooklyn	Queens	Richmond		Manhattan	Bronx	Brooklyn	Queens	Richmond		
Under 5	2	0	3	0	0	5	1	1	1	2	0	5	10
5–9	8	2	7	1	0	18	7	0	3	2	0	12	30
10–14	11	4	8	0	1	24	10	2	2	2	0	16	40
15–19	9	4	12	2	2	29	16	4	5	1	0	26	55
20–24	32	6	16	6	6	66	43	8	10	4	0	65	131
25–29	21	7	16	9	3	56	45	11	24	6	2	88	144
30–34	23	5	17	9	1	55	29	5	14	9	0	57	112
35–39	20	3	12	5	2	42	25	4	7	0	0	36	78
40–44	31	2	12	7	4	56	23	0	2	3	1	29	85
45–49	13	3	10	6	3	35	11	2	4	3	0	20	55
50–54	13	1	7	1	3	25	9	1	4	1	0	15	40
55–59	11	0	2	2	0	15	4	0	1	0	0	5	20
60–64	3	0	1	0	0	4	3	0	1	0	0	4	8
65–69	3	0	0	2	0	5	2	0	1	0	0	3	8
70–74	0	0	0	0	0	0	0	0	1	0	0	1	1
75–79	0	0	1	0	0	1	0	0	0	0	0	0	1
Total	200	37	124	50	25	436	228	38	80	33	3	382	818

Grand total by boroughs: Manhattan, 428; Bronx, 75; Brooklyn, 204; Queens, 83; Richmond, 28; total, 818.

The distribution of the cases between the sexes for the city as a whole is approximately that usually found in typhoid outbreaks. However, in the Borough of Manhattan the females of all ages are found in slight excess, and in the age group 20 to 34 years of age the number of females in the Borough of Manhattan is far in excess of the males (76 males, 117 females). The age-sex distribution was unusual and is significant (see p. 69).

RACE

The outbreak was confined almost entirely to the white race, only five of the cases shown in Table No. 28 being in colored persons. This gave a case incidence, for the period under consideration, of 2.93 for the colored population, while the rate for the white population was 13.9 per 100,000. Had the case incidence been the same for the colored as for the white population, there would have been 27 cases reported in colored persons instead of 5.

STUDY OF OUTBREAK

The intensive epidemiological study of the outbreak by the United States Public Health Service was begun on January 5, 1925. A sufficient number of cases to give a representative group of those affected was investigated independently of similar investigations of cases by the New York City health department. This was done in order that the results obtained might be compared in detail if any significant differences were found relating to the cause of the outbreak.

The cases selected for investigation were taken from the list of cases reported to the New York City health department. Cases from all boroughs were included. As a rule, those cases were taken in neighborhoods showing the greatest number, though in Queens and Richmond Boroughs the cases were rather widely scattered. No consideration was given to age nor to economic conditions. Cases known to have terminated fatally were as a rule avoided, as a history in such case must necessarily be given by relatives and under such conditions that it might not be reliable. Notwithstanding this, calls were made at a few addresses where the cases had terminated fatally, and if the officer taking the history was satisfied that it was reliable, it was included in the study.

Special effort was made to obtain the information from the person affected in every case when this was possible. The information was obtained by three medical officers of the Public Health Service. Two hundred and eighty-two cases were visited. Nineteen were discarded on account of very incomplete or unreliable histories, or because

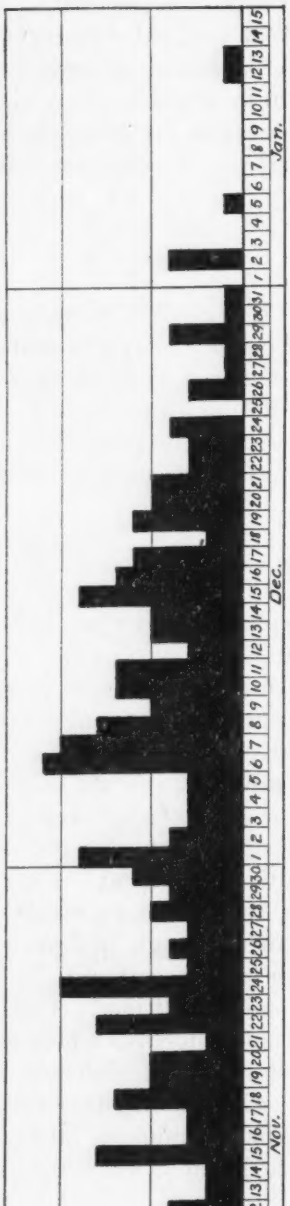


CHART NO. 6.—Onset of cases investigated in New York City

they had occurred before the beginning of the outbreak. Two hundred and sixty-three cases gave histories sufficiently complete to warrant consideration, and in this report reference to cases investigated means this number, unless otherwise specified.

Chart No. 6 shows the date of onset of 263 cases investigated by the Public Health Service, the date of onset being the date the person took to bed.

GEOGRAPHICAL DISTRIBUTION OF INVESTIGATED CASES

Of the 263 cases investigated, 257 were reported to the New York City Department of Health. The remaining six were in persons residing outside the city limits, but as the infection seemed to have been contracted in New York City they were included in the investigation. This group of six cases was brought to the attention of the investigators because one of the resident cases was in a person who was exposed along with this suburban group to food and beverages supplied at a certain banquet.

The cases investigated were distributed geographically as follows:

Borough of Manhattan	109
Borough of the Bronx	39
Borough of Brooklyn	71
Borough of Queens	31
Borough of Richmond	7
Outside city limits	6
Total	263

OCCUPATION

Table No. 29 shows the occupation of the 263 cases investigated, segregated into groups.

TABLE No. 29

Group		
1	Professional	30
2	Engineering and contracting	8
3	Real estate, brokers, and insurance	6
4	Executives and public officials	9
5	Clerical, stenographers and salesmen	53
6	Merchant and manufacturing	22
7	Skilled labor	15
8	Unskilled labor	4
9	Not gainfully employed [1]	116
	Total	263

[1] Includes housewives, students and school children, retired men, and those having no occupation.

SANITARY AND ECONOMIC CONDITIONS

The sanitary and economic conditions under which the persons affected lived were far above those ordinarily found in outbreaks of infectious disease. The economic conditions were classified as follows: Excellent or good, 208; fair, 39; poor, 9. Many of those recorded as excellent or good could be classified as wealthy, but it was deemed best to use only the classes stated above.

IMMUNIZATION

Five of the 263 cases investigated stated that they had suffered from typhoid fever once before the present attack. One stated he had typhoid fever in 1868, one in 1890, one in 1894, one in 1901, and one in 1904.

Eleven stated that they had received typhoid vaccine—one in 1908, one in 1915, one in 1917, five in 1918, one in 1919, and two in 1924. One of those receiving vaccine in 1924 received his first dose of vaccine five weeks before he went to bed on account of typhoid fever.

OUT-OF-TOWN INFECTION

The history of the cases included a statement of the travels of each person affected during the 30 days preceding illness.

Of 263 cases, 161 gave no history of having been away from New York City during the 30 days preceding illness; 42 had been away frequently or for extended periods and were classed as probable out-of-town infections; and 60 in persons who had been away infrequently or for short periods were classed as possible but not probable out-of-town infections. Though the reason for out-of-town trips was not asked and recorded as a routine matter, the notes made indicated that about half of the trips were of a business nature and the others of a social nature.

WATER

The general character of the outbreak, the low incidence of the disease in the poorer class, and the relatively low incidence among children were not suggestive of water-borne infection. The distribution of cases, when compared to the distribution of the different public water supplies, also gave no indication that the outbreak was due to a polluted water supply. In order that any condition, not readily apparent, might not be overlooked, Asst. Sanitary Engineer E. C. Sullivan, of the Public Health Service, was directed to make a study of the public water supply of New York City for the period of causation of the outbreak. This included consideration of the sources, storage, chlorination, distribution, and routine bacteriological examination of the water furnished the city. His conclusion, based upon the information and data received during his investigation, is that the New York City water supply can not be considered as having been a factor in the recent typhoid fever outbreak.

Bottled waters are used to some extent in New York city, especially in business offices. This is not because of any suspicion of the public water supply, but largely on account of the convenience of icing and keeping the containers clean. Various bottled water companies look after this by contract and save the business firms the trouble of obtaining ice, having containers cleaned and filled, and other minor details connected with the furnishing of drinking water in an office.

Of the 263 cases investigated, 37 had used bottled water to some extent, 222 had used no bottled water, and 4 were uncertain or gave no information. Of the 37 using bottled water, 10 did not know the source of the water used and the remaining 27 used bottled water from 14 different sources. In view of the small number of typhoid cases among the persons who had used bottled water and the small number of cases among those who used any one kind of bottled water, it is apparent that bottled water is not to be considered as having been a probable vector of typhoid in the outbreak under consideration.

MEALS, WHERE TAKEN

The inquiry as to where the persons had taken their meals during the 30 days preceding illness revealed the fact that a vast majority had taken one or more meals away from home. Many took lunch at a restaurant or lunch room daily, except Sundays or holidays, and many others took meals outside the home regularly on Sundays and, in some cases, on other days of the week.

Of the 263 cases investigated, the history of meals taken by one (a fatal case) was uncertain; 51 were in persons who took meals at home or at regular boarding places only; 27 in restaurants only; and 184 had taken meals both at home and at restaurants or lunch rooms.

Of the 211 persons affected who ate at restaurants or lunch rooms in the 30 days preceding the onset of their illness, 22 had eaten at such places once only, 41 occasionally, and 148 frequently. Many of these were patrons of high-class restaurants, where variety of food and good service are demanded without regard to the cost of the meal. This high incidence among persons frequenting public eating places might be taken to suggest the possibility of typhoid carriers among food handlers at restaurants. However, upon considering the large number of restaurants or lunch rooms involved, it becomes obvious that a large number of carriers would have had to be employed in such places and that many of them would have had to become exceedingly and unusually active at about the same time. Such a condition is, to say the least, highly improbable.

Remembering that typhoid infection is received only through the mouth, and in the absence of evidence of water-borne infection, the next factor carefully considered from the early part of the study was food. As cooked foods are practically always sufficiently heated to kill any typhoid germs present we naturally proceeded to a consideration of various foods that are eaten raw.

MILK

In this report the term milk includes both fresh milk and cream. One hundred and three cases were in persons who had used fresh milk as a beverage at some time during the 30-day period preceding onset of illness; 112 used it on cereals or for other general table purposes, but not as a beverage; 31 used it in tea or coffee only; 13 used no fresh milk and 4 gave an uncertain history as to use of milk. The number of cases among the consumers of milk supplied by each milk company was roughly proportionate to the amount of milk distributed by each of said companies.

Table 30 shows the number of cases of typhoid fever occurring among the patrons of each milk company and the amount of milk distributed by these companies on a single day.

TABLE NO. 30.—*Cases of typhoid fever among patrons of different milk dealers in relation to total amount of milk distributed*

Distributing company	Number of cases in persons known to have used milk from each company	Quarts of milk distributed in one day in New York City	Per cent cases in persons known to have used milk from each company	Per cent of total supply of milk distributed
A	109	825,000	50.9	50.5
B	94	527,601	43.9	32.3
All other companies	[1] 21	280,814	9.8	17.2
Total	224	1,633,415	[2] 104.6	100.0

[1] Not more than 6 from any one company.
[2] In 10 cases milk was used from more than one company.

Mathematical exactness is not to be expected in the proportion of cases to amount of each of the milk supplies distributed, but the percentages presented in Table 30 indicate that there was no markedly excessive prevalence of typhoid fever among the users of milk from any of the supplies. If all the cases occurring in the outbreak had been covered by this study it is probable that the number of cases to amount of milk distributed by each of the principal dairy companies would be in more nearly exact proportion than is shown in this table.

The infrequency of typhoid fever in young children in this outbreak also is evidence that milk was not an appreciable factor in the spread of the infection.

ICE CREAM

Owing to the many places at which ice cream may be eaten, such as drug stores, confectionery stores, lunch rooms, hotels, and restaurants, it was exceptional to find a patient who could state the source of the ice cream consumed. However, in 39 cases definite statements were obtained as to the source of the ice cream eaten. Seven sources of ice cream were given and the number of cases among users of the product from each of these supplies was 13, 11, 6, 1, 1, 1, and 1, respectively, and five stated their ice cream was homemade. From all data obtained this distribution of cases appeared approximately proportionate to the output of these manufacturers.

Twenty-one persons affected gave an uncertain history as to eating ice cream; 81 ate no ice cream during the 30 days preceding onset of illness; 7 ate ice cream once; 94 ate it occasionally, and 60 frequently. The lines of evidence gathered from the ice cream histories do not converge to any point, or points, indicating that infection was received through any particular producing or distributing place, or from any particular kind of ice cream. The low incidence of typhoid fever in children is also evidence against ice cream having been a considerable factor in the causation of the outbreak.

BUTTER AND CHEESE

Practically every person affected used butter to some extent. Few could state the brand of butter used in their homes, and those eating at hotels, restaurants, or lunchrooms could give no information as to the source of butter used.

The general character of the outbreak did not suggest butter as a vector of infection. Children are known to be butter eaters as much, if not more, than adults, as a result of "between meal" lunches, yet the incidence of typhoid fever in children during the outbreak was low. On the other hand, the incidence among the well to do was high. This class, though large consumers of butter, buy only the best grade of butter, and high grade butter is, almost without exception, pas-

teurized. In fact, nearly all the butter entering New York City is made from pasteurized cream, as pasteurization adds to its commercial value. The methods of distribution of butter in the market are such that widespread contamination of butter in stores or markets is practically impossible. There was no evidence of any undue proportion of cases among users of butter from any of the city's supplies.

Histories of 101 persons affected showed that they had eaten cheese, and 68 stated that they ate none; of the 101 eating cheese 55 ate it frequently and 46 occasionally.

The following tabular statement shows the kind of cheese eaten. Several cases were in persons who had eaten more than one kind, and such cases appear as one under each kind eaten.

Kind of cheese	Number eating	Kind of cheese	Number eating
Cream	40	Italian	4
Swiss	26	Cottage	2
American	12	Roman	1
Roquefort	9	Pimento	1
Camembert	6		

Fifty-seven cases stated the source of their cheese definitely, and these obtained their cheese from 49 different stores. One large dairy supplied cheese to 3 cases, and four chain stores furnished cheese to 3, 2, 2, and 2 cases, respectively. One small store furnished cheese to 2 cases.

The evidence obtained did not tend to implicate any particular kind of cheese nor the cheese distributed from any particular store.

RAW VEGETABLES

Although information was obtained concerning the eating of all raw vegetables, it soon became apparent that only two—viz, celery and lettuce—were consumed by a sufficient number of persons affected to require consideration as a possible factor in the spread of the infection. The data obtained are shown in the following table (No. 31):

TABLE No. 31.—*Showing persons eating raw vegetables*

	None eaten	Uncertain	Frequently	Occasionally	Once	Total eating	Per cent eating
Celery	48	7	88	107	13	208	81.2
Lettuce	34	7	153	68	1	222	86.7

A large proportion of the cases gave a history of eating celery or lettuce both at home and in restaurants. The sources from which vegetables were obtained were many and various. Celery and lettuce for consumption in the home were usually purchased from retail dealers in the neighborhood, who, in turn, bought from a jobber. The vegetables may have passed through the business of from three

to six middlemen between the dealer receiving the carload lot and the retailer. This made the tracing of home-consumed vegetables practically impossible. Therefore a canvass was made to determine whether the incidence of typhoid in the outbreak had been disproportionately high among eaters of celery or lettuce. This canvass was conducted in a group of persons who did not furnish any of the cases of typhoid fever, yet lived under the same general economic and social conditions as those affected. The findings will be given later, as the data cover other possible factors besides lettuce and celery (see pp. 78 and 79).

RAW CLAMS

Twenty-four of the cases gave a history of having eaten raw clams during the 30 days preceding the onset of illness. Seven ate raw clams frequently; 11 occasionally, and 6 on a single occasion only. Fourteen gave an uncertain history as to eating clams, and 224 were in persons who ate no clams within the period. The fact that 90 per cent of the persons affected who were able to give a definite history as to the consumption of clams stated that they ate no raw clams, seems sufficient to warrant the dismissal of raw clams as a considerable factor in the causation of the typhoid outbreak.

RAW OYSTERS

Of the 263 cases investigated, 176 gave a history of having eaten raw oysters within the 30-day period preceding the onset of illness. With a single exception, all of these 176 ate oysters on the half shell only, the exception having been in a person who ate raw shucked oysters in a cocktail, in addition to oysters on the half shell. Seventy persons affected stated they had eaten no raw oysters and 17 gave an uncertain oyster history. Of the 176 giving a history of eating raw oysters, 65 ate them frequently, 40 occasionally, and 71 once only. The following table (No. 32) shows the number that ate raw shellfish.

TABLE No. 32.—*Showing persons eating raw shellfish*

	None eaten	Uncertain	Frequently	Occasionally	Once	Total eating	Per cent eating
Raw clams	224	15	7	11	6	24	10.0
Raw oysters	70	17	65	40	71	176	71.5

The high percentage of oyster eaters among the persons who developed typhoid fever is striking. Another striking fact was the large number that had eaten raw oysters once only. Fifty-nine of the 71 persons affected, who stated they had eaten raw oysters once only, were able to remember the date upon which the oysters were eaten. In these 59 cases the average time elapsing between the date

of the single ingestion of oysters and the definite onset of typhoid fever was 22.05 days.

During the collection of data it became evident that a large proportion of the cases had been in persons who ate raw oysters in hotels or restaurants of the best class and that in many instances two or more of the persons affected had eaten raw oysters at the same hotel or restaurant.

One hundred and fifty-two of the persons affected ate raw oysters in restaurants or hotels; five ate raw oysters both at home and at restaurants, and 19 ate raw oysters at their own or other private homes only. For those residing in Manhattan it is far more convenient to go to a restaurant for a meal than for those residing in some other boroughs, particularly Richmond Borough. Definite statements as to the kind of oysters ordered from the menu card were obtained in 43 of the cases. Of the persons furnishing these 43 cases, 37 ordered Bluepoints, 3 Lynnhavens, 2 Cape Cods, and 1 Cotuits. Ten others gave information as to the size of the oysters eaten. Four stated they ate small oysters, two ate medium, and four ate large oysters. The statement by a majority of the 53 persons that they ate Bluepoints, or small oysters, suggests an explanation of the unusual prevalence of the disease among females. Women, as a rule, eat small oysters more than men.

Although 176 persons gave a definite history of having eaten oysters, not all of these could give a sufficiently complete history to enable us to trace the oysters eaten. Many could state positively they had eaten oysters at restaurants but could give only an approximate address without the name of such restaurant. It was soon found that such addresses were useless in most cases, as usually there were several restaurants in the block named and there was no way of ascertaining the one at which the person had eaten. A few restaurants had gone out of business and two had burned. A number that were scattered in suburban or residential districts were communicated with by letter and some failed to answer our request for information. However, in 96 cases the history was sufficiently complete to enable us to ascertain the dealer from whom the restaurant, or market, obtained oysters.

The greater part of the oysters distributed in New York City are purchased through wholesale dealers. Some of these dealers grow a portion of the oysters sold by them on beds owned or controlled by them. Incase large orders are received, wholesale dealers may buy sufficient oysters from a producing company and instruct the producers to ship the same direct to the purchaser. This is frequently done in filling the orders of large hotels or restaurants. A smaller portion of the oysters entering New York City are shipped direct from the producers to the retailers, or to a restaurant or hotel, without passing through a wholesale house.

Furthermore, one dealer may buy from another at times to complete an order in case his own stock is low.

In some cases it was found that the oysters eaten on different occasions had come from different sources of supply. We therefore adopted the term "exclusively exposed" when the person exposed had eaten oysters coming from only one dealer or producer, and "potentially exposed" when they came, or might have come, from more than one dealer, or producer.

The oysters eaten by the 96 persons whose histories were sufficiently complete on this point came through a total of 18 different wholesale dealers and from 6 producing companies shipping direct to retailers or to hotels and restaurants. As most of the wholesale dealers received oysters from more than one producing company, we found, in tracing the oysters eaten, that the lines converged to the dealers and then diverged to two or more producing companies. In a few cases the oysters were traced direct from the restaurant at which they were eaten, or the market from which they were obtained, to the producing company that shipped the oysters from its plant. In other words, some oysters did not pass through the business of one or more middlemen. The source of the supply of oysters to all dealers is not known, as some failed to furnish us with information requested upon this point. In some instances information as to the source of at least a part of their supply has been obtained from shipping or producing companies, or from other dealers in case of a transaction between dealers.

Table No. 33 shows the number of cases giving definite histories among persons potentially or exclusively exposed to oysters distributed by 18 wholesale dealers and indicates the sources of the supplies of such dealers.

TABLE NO. 33.—*Exposure of cases to oysters passing through the business of wholesale dealers*

Dealer	Number of cases potentially exposed	Number of cases exclusively exposed	Source of supply
I	1	0	Company W; others unknown.
II	1	0	Company W and dealer XIV.
III	1	0	Company W and dealer XIV.
IV	17	10	Companies A, J, and M.
V	1	0	Company W; others unknown.
VI	5	1	Companies A, I, and J.
VII	56	25	Companies A, H, L, S, T, and U.
VIII	3	1	Companies A, H, I, and W.
IX	3	0	Comapnies A and W; others unknown.
X	17	2	Companies A, H, I, J, and W.
XI	1	1	Company A; others unknown.
XII	3	2	Dealers XIV and XV; others unknown.
XIII	10	0	Company H and dealer XV.
XIV	3	0	Companies F, I, J, K, and smaller shippers.
XV	2	0	Companies D, I, J, O, V, and X.
XVI	1	0	Unknown.
XVII	2	0	Company W and dealer XV.
XVIII	1	0	Dealer XIV; others unknown.

Dealer XIV received oysters from five small shippers not designated in the right-hand column of Table 33. The list of the business of dealer XIV was carefully made, so it was possible to trace the oysters received by him from each shipper to the customer buying the same. All oysters coming from those five small shippers went, as nearly as could be ascertained, to restaurants or retailers, who were not involved in any of the cases investigated.

The following table (No. 34) shows the number of persons potentially exposed and exclusively exposed to oysters going from producing company to restaurant or retailer without passing through the business of a middleman.

TABLE No. 34.—*Persons exposed to oysters shipped direct from producing company to retailers or restaurants*

Producing or shipping company	Cases potentially exposed	Cases exclusively exposed	Producing or shipping company	Cases potentially exposed	Cases exclusively exposed
A	5	2	G	1	0
E	1	0	N	14	0
F	5	3	X	3	1

Following the oysters back through the wholesale dealer to the original shipping or producing companies known to have shipped oysters to these dealers within the period of the causation of the outbreak, we find that in many cases it is impossible to be certain that oysters bought from a certain company on a certain date went to any certain retailer or restaurant. Some of the lists furnished show this accurately and the care taken by those furnishing such lists helped us greatly in this part of the work. When the information furnished was not sufficient to make it possible to trace from the wholesale dealer to the original shipper, the rule adopted was to consider that a person might have eaten oysters coming from any of the producing companies that shipped oysters to the wholesale dealer involved. In such cases the exposure was counted as potential to oysters from each of the shippers that sent oysters to that particular dealer. Therefore, the total of potential exposures should point to the infected supply or supplies.

Twenty-three different shipping or producing companies shipped oysters to wholesale dealers in New York City through whose establishments oysters involved were traced. The amount shipped was given by some dealers but not by all, and consequently it was impossible to determine mathematically the probability of infection coming from any stated company.

For example, dealer VII received 1,594 barrels from company A, 767 barrels from company H, 1,748 barrels from company L, 103 barrels from company S, 305 barrels from company T, and 251

barrels from company U. Obviously, if typhoid infection had been distributed equally throughout all these oysters, company A and company L should have 16 and 17 times as many cases, respectively, as company S.

The number of persons potentially exposed to oysters from each of the different shipping companies is shown in Table No. 35. This is based on the 96 cases whose histories were sufficiently complete to trace the oysters back to the dealer and then to the shipping companies.

TABLE No. 35.—*Cases exposed to oysters coming from one or more of 23 producing companies*

Company	Number of persons potentially exposed	Number of persons exclusively exposed	Company	Number of persons potentially exposed	Number of persons exclusively exposed
A	89	2	N	14	0
B	2	0	O	16	0
D	16	0	P	9	0
E	1	0	Q	9	0
F	11	3	R	9	0
G	1	0	S	56	0
H	66	0	T	56	0
I	38	0	U	56	0
J	48	0	V	16	0
K	8	0	W	9	0
L	56	0	X	3	1
M	16	0			

The above table shows that company A furnished the largest number of potential exposures, followed in order by companies H, L, S, T, U, J, and I.

Company A's supply, having the largest number of potential exposures (89) charged against it, is necessarily regarded as a possible source of the infection. Company A furnished oysters to seven dealers, including some of the largest wholesale dealers in New York City.

Of 48 cases giving a history of exclusive exposure to the oysters distributed by some one dealer, 42 were exposed to oysters supplied by some one of such dealers who bought oysters from company A. To eliminate company A as a factor it would be necessary to show that a preponderance of the cases can be reasonably attributed to infected oysters coming from some other producing company, or companies, to these middlemen.

Company H had the second largest number of cases (66) potentially exposed to its oyster supply. Every one of these cases, however, was also potentially exposed to oysters from company A. Diagram No. 4 illustrates the distribution by company H to dealers VII and XIII.

Dealer XIII obtained about 90 per cent of his shell oysters from company H and none from company A. Furthermore, dealer XIII

with 10 potentially-exposed cases charged against his supply bought approximately twice as many oysters from company H as did dealer VII, who had 56 potentially exposed cases charged against his supply; and 25 of this latter number were exposed exclusively to oysters obtained from dealer VII. It is reasonable to assume that if the infection had been in the oysters of company H, dealer XIII would also have at least a few exclusive exposures and a larger number of potential-exposure cases traced to his establishment. It therefore seems likely that company H did not furnish an appreciable amount of infected oysters during the period of causation of the outbreak.

Companies L, S, T, and U have charged against their supplies, both separately and together, 56 potentially exposed cases. The

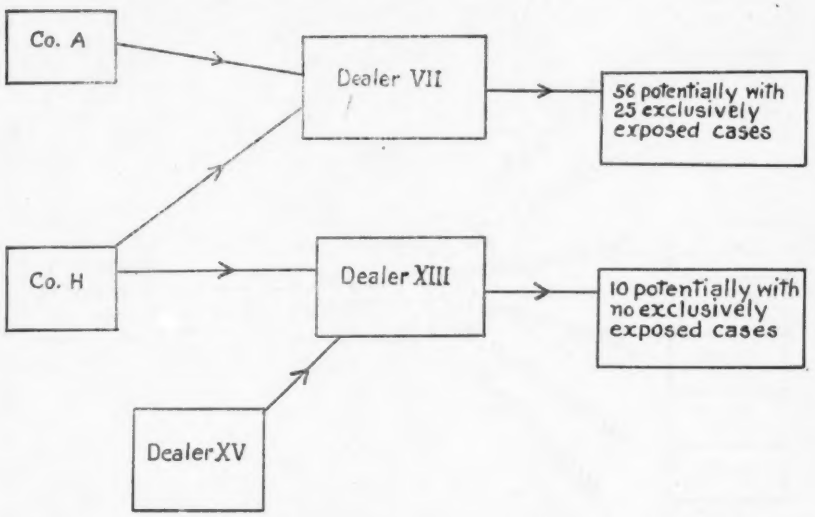


DIAGRAM NO. 4.—Showing distribution of oysters from producing companies A and H, through dealers VII and XIII

coincidence of cases potentially exposed to the supply of each of these four producers is explained by the fact that all four producers sold to dealer VII only. Dealer VII was supplied also by companies A and H. Company S shipped only 100 barrels to dealer VII on December 2, and this shipment arrived in New York too late to have played an appreciable rôle, if any, in the outbreak. Likewise, company T shipped 305 barrels which arrived December 22–24, too late to have played a part in the outbreak. Company U shipped 250 barrels of oysters to dealer VII between November 7 and December 20 from a large oyster-producing area in distant waters. The vast bulk of the oysters from company U and other companies operating in that area went to other cities and evidently could not have been an appreciable factor in the spread of the infection causing the outbreak.

Company L shipped approximately 1,750 barrels of oysters to dealer VII, but as practically all of this company's oysters were of such a quality that they do not sell readily for shell oysters they were shucked and distributed as shucked oysters. As the histories of the typhoid fever cases reveal so few instances of shucked oysters being eaten, this alone practically eliminates company L as a contributor to the outbreak.

As it appears that the 56 potentially, with the 25 exclusively, exposed cases among the patrons of dealer VII are not chargeable to oysters supplied by companies H, L, S, T, or U, the incidence is, therefore, chargeable to the oysters supplied this dealer by company A. This evidence is strengthened by the fact that company A had 31

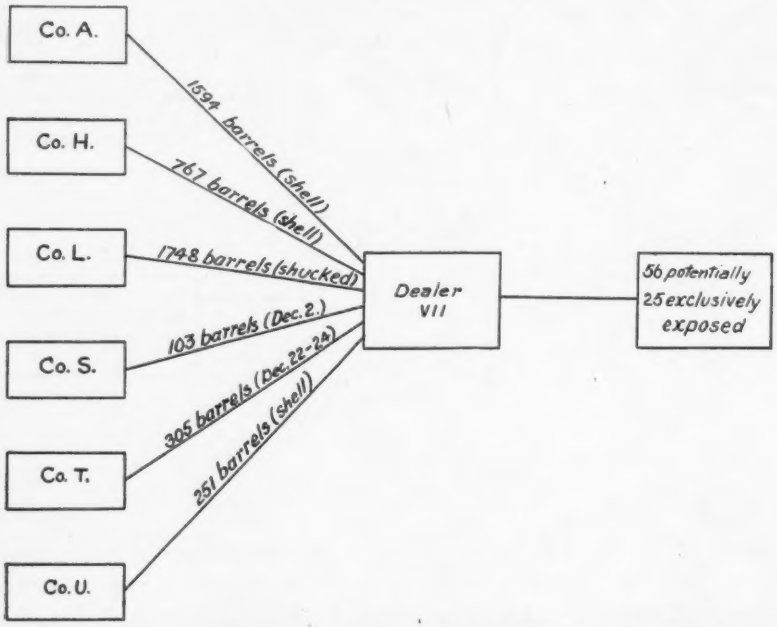


DIAGRAM NO. 5.—Showing sources of oyster supply of dealer VII, Nov. 1, 1924, to Dec. 25, 1924

other potentially exposed cases charged to its oysters distributed through other wholesale dealers. Diagram 5 shows the sources of supply of dealer VII for the period November 1 to December 25, 1924.

Company J, with 48 potentially exposed cases, sold oysters to dealers IV, VI, X, XIV, and XV, and through dealer XIV some of these oysters reached dealers II, III, XII, and XVIII, and through dealer XV some reached dealer XIII and dealer XVII. Of these 48 potentially exposed cases, 45 were also potentially exposed to oysters of company A. None of the oysters of company J were distributed by dealer VII. As all of the 56 potentially exposed cases charged to dealer VII were potentially exposed to company A's oysters and as 45

of the 48 cases potentially exposed to company J's product were also exposed to company A's oysters, it seems logical to assume that company A's oysters were the main factor in conveying whatever oyster-borne infection operated in the outbreak.

Company I had 38 cases potentially exposed to its oysters, and of this number 35 were also potentially exposed to oysters of company A. None of the oysters from company I passed through the hands of dealer VII. Company I furnished a large majority of the shell oysters distributed by dealer XV. This dealer had only two potentially exposed cases among persons eating at restaurants to which he sold direct, and had 14 other cases potentially exposed to his oysters which were distributed through other dealers to whom he sold. Ten of these 14 cases were potentially exposed through the supply sold by dealer XIII who obtained about 10 per cent of his

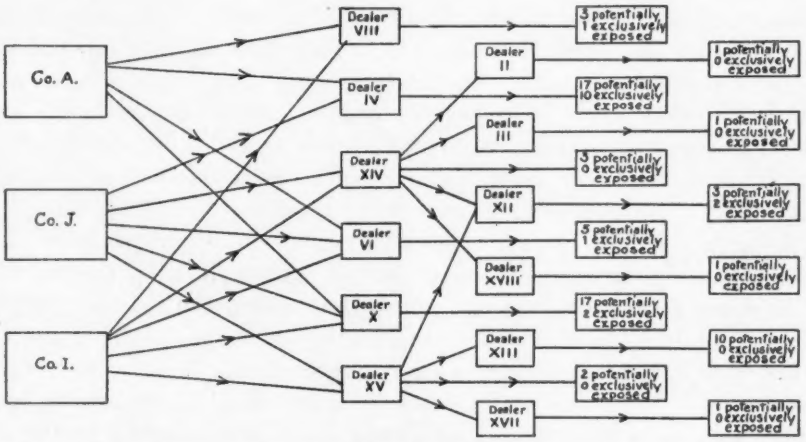


DIAGRAM NO. 6.—Showing distribution of oysters from producing companies A, I, and J, through dealers involved

shell oysters from dealer XV. Neither dealer XV nor XIII had any cases exclusively exposed to oysters sold by them. Diagram 6 illustrates distribution by companies I and J to various dealers.

Company M sold oysters only to dealer IV who bought a large majority of his shell oysters from company A. Therefore, all cases potentially exposed to company M's oysters were also potentially exposed to company A's product. However, company M shipped no oysters to dealer VII, who, as is stated above, had a large number of potentially exposed cases traced to his establishment. Dealer VII handled a large amount of company A's oysters and dealer IV did likewise. Company M's supply of oysters was from beds in a distant area which obviously was not involved in the typhoid outbreaks. It therefore seems certain that the cases traced to dealer IV should be charged against company A's supply.

Companies D and O shipped only to dealer XV, who, in turn, sold to dealer XIII supplying him with about 10 per cent of the oysters which he sold.

Company V also shipped only to dealer XV but this company's oysters were of a quality that do not sell readily for half-shell purposes and these were shucked and sold as shucked oysters. As has been indicated above, the oysters sold by dealers XV and XIII could not have been a considerable factor in the spread of the infection. Therefore, the supplies furnished them by companies D, O, and V can be eliminated.

Company N shipped direct to large hotels. Fourteen cases among oyster eaters at these hotels were potentially exposed to company N's oysters. However, company A's oysters also went to these same hotels through dealer VII, who furnished these hotels with nearly three times as many oysters as did company N. At least a part of those furnished these hotels by company A were shipped direct to the hotel on the order of dealer VII. Therefore, all of those potentially exposed to company N's products were also exposed to company A's oysters. If company N's oysters had been responsible for the infection, the outbreak of typhoid fever would have been limited to the patrons of two hotels, which, so far as could be ascertained, served all of company N's oysters that came into New York City.

Company F had 11 cases potentially exposed to its product, six of these being through shipments sent to dealer XIV in December. Five cases were traced through hotels that obtain their supply direct from company F and three of these ate oysters at no other place. This casts a suspicion on the oysters supplied by company F, but in view of the small number of cases involved, such oysters could not have been more than a comparatively small contributory factor, if any. It should be stated, however, that company F has its plant near that of company A, and it is understood that transactions in oysters between these companies occurred frequently. (See Diagram No. 7.)

Companies P, Q, and R shipped 30, 18, and 13 barrels, respectively, to dealer XIV. Only 9 potentially exposed cases can be charged against their oysters and these are widely scattered through the business of five dealers.

Companies W, K, X, B, E, and G, with 9, 8, 3, 2, 1, and 1 potentially exposed cases, respectively, have too few cases charged against their supplies to be significant, most of such cases being also potentially exposed to the oysters of other companies.

Five of the cases were in persons who ate oysters that came direct from company A to the restaurant, or market, involved. Two of these cases were exclusively exposed to company A's oysters. When we add these cases to the 84 cases potentially exposed to this company's oysters distributed by middlemen and consider the impossibility

of eliminating company A's oysters as a probable source of infection, we must conclude that the preponderance of evidence points to the oysters distributed by company A as the major factor in the conveyance of the infection causing the recent typhoid outbreak in New York City. The conclusion that the oysters distributed by company A were the major factor becomes practically certain when the evidence here is considered in connection with that found in Chicago, Washington, and other cities, where the less complicated method of distribution of oysters and the complete cooperation of oyster dealers made the accurate tracing of the oysters much more simple.

In support of such conclusion is the occurrence of typhoid fever among persons attending a banquet at one of the large New York City hotels on November 18. About 700 persons attended this banquet. Within a period of 30 days thereafter, 10 of these persons developed typhoid fever. Seven of these cases were included in the 263 investigated, 6 being in persons residing outside the city limits.

It was ascertained that dealer VII delivered 15 barrels of oysters on November 17 and 10 barrels on November 18 to this hotel. Two barrels of oysters were also received from company N on November 18, but the hotel authorities are reasonably sure that the oysters served at this banquet were exclusively those obtained from dealer VII on November 17. The two barrels from company N would not be sufficient to serve 700 persons. Furthermore, if the cases resulting from this banquet are excluded there were only 8 cases among the 263 investigated giving a history of potential exposures to company N's oysters.

At this dinner the guests ate at tables accommodating from 6 to 20 persons. Four of the seven cases investigated developed among 16 persons who were seated at one table (No. 60). Of the 16 persons at this table, 6 ate no oysters but most of these 6 ate celery and lettuce and various other foods served. Five of the 10 who sat at table 60 and ate oysters developed typhoid fever within 30 days thereafter. The statement that six ate no oysters was obtained from two persons who sat at the table, one of whom ate no oysters, while the other ate oysters but did not develop typhoid fever. Two of the remaining five that developed typhoid fever following this dinner sat at other tables, and the seating of the remaining three is uncertain, as they were guests and did not appear on the seating list. The 10 cases developing typhoid were equally divided between the two sexes. Two occurred in one family (man and wife). One was a middle aged lady who seldom dined out and as a rule did not eat raw oysters. However, at this dinner a friend persuaded her to eat oysters. One lady who ate oysters developed typhoid while her husband, who ate no oysters but who did eat freely of celery and the various other foods served, did not develop typhoid fever.

The oysters were opened by several shuckers on the afternoon of November 18 and placed on cracked ice on trays and the trays placed in the refrigerator. The method of serving the oysters, which was ascertained in detail, was such as to make it entirely possible for infected oysters from one segment of one barrel, composing but a small proportion of the whole quantity distributed, to have reached the persons who became infected. Each waiter carried five plates of oysters on each trip to his table. Since the oysters were delivered to the waiters in the same order that they were placed in the refrigerator, it can be understood how one waiter could have delivered to his table five plates of oysters from the infected batch and upon his next trip obtain oysters from another part of the supply.

It was also learned that the celery and lettuce served at this banquet was from the hotel's regular supply, all of which is washed in a hypochlorite solution before being served.

CONTROL OBSERVATIONS

A canvass was made among a control group of persons living under conditions comparable to those of the persons affected with typhoid to ascertain the percentage eating raw oysters, raw celery, or raw lettuce. The figures obtained are given in the following table (No. 36), the figures from Tables No. 31 and No. 32 being repeated to make comparison easier.

TABLE 36.—*Consumption of raw lettuce, celery, and oysters by a control group compared to that by the group that had typhoid fever*

	Number of persons questioned	Number that ate raw celery	Number that ate raw lettuce	Number that ate raw oysters	Percentage		
					Celery	Lettuce	Oysters
Control group	275	188	196	28	68.36	71.3	10.18
Typhoid fever group	[1] 256	208	222		81.2	86.7	
	[1] 246			176			71.5

[1] Of 263 typhoid cases investigated 7 gave an uncertain history of eating celery or lettuce and 17 an uncertain history of eating raw oysters. These cases are not considered in this table.

The control group was canvassed by visiting the homes of the persons in the evening hours when all members of the family would most likely be at home. Data were taken only from persons interrogated directly. One hundred and forty-one families made up of 440 individuals were canvassed and 275 persons were questioned directly. The canvassing was made by specially qualified nurses from the division of communicable diseases of the New York City Department of Health.

It will be noted that the percentage of persons in the typhoid-fever group that ate raw oysters is seven times that in the control group—a difference of 60 per cent. Of those eating celery and

lettuce, the difference is 13 and 15 per cent, respectively. This alone suggests the probability of raw oysters as a factor in the spread of the typhoid infection and shows that a large proportion of the unaffected population ate raw celery and lettuce and only a small proportion ate raw oysters. However, in the group that suffered in this typhoid outbreak, 71 per cent ate raw oysters one or more times in the 30 days preceding the onset of illness.

SUMMARY

Epidemiological data were obtained from 257 of 913 cases of typhoid fever reported in New York City in the period November 1, 1924, to February 14, 1925. Data were also obtained from six cases residing outside city limits in Nassau County which were among the cases reported in that county. These 263 cases are believed to be fairly representative of the whole number of cases in the outbreak.

The data obtained show that a majority of the persons received the infection in New York City, and were sufficient to eliminate the water supply, milk and milk products, and raw vegetables as considerable factors in the causation of the outbreak. All the evidence definitely points to one major causative factor, viz, raw shell oysters.

Seventy-one per cent of those having typhoid fever during the outbreak had eaten raw shell oysters within the 30-day period immediately preceding the onset of illness. In an equally large group living under similar economic and social conditions but not having typhoid fever, only 10 per cent ate raw shell oysters.

For 96 cases, the oysters eaten were traced to their probable sources. Eighty-nine (or 92.7 per cent) of these 96 cases had been potentially exposed to oysters distributed by company A, and 2 were exclusively exposed to oysters shipped by this company.

Of the seven cases not potentially exposed to oysters distributed by company A, three were exclusively exposed to oysters distributed by company F. Company F operates in the same immediate vicinity as company A and, according to statements obtained, there was trade in oysters between these two companies.

CONCLUSION

The preponderance of evidence obtained from this limited epidemiological study of the typhoid outbreak in New York City is that the major factor in the spread of the infection here was raw shell oysters distributed by company A, and that raw shell oysters distributed by company F were possibly a contributory factor.

Section V

THE EXCESSIVE PREVALENCE IN TEN OTHER CITIES

(Pittsfield, Mass.; Providence, R. I.; New Haven, Conn.; Rochester, Buffalo, N. Y.; Scranton, Pittsburgh, Pa.; Cincinnati, Ohio; Detroit, Grand Rapids, Mich.)

During the period when the outbreaks of typhoid fever were reported in New York City, Washington, and Chicago, typhoid rates higher than usual were reported from a number of other cities in the United States (see pp. 5 to 9).

Table No. 37 gives (A) the usual or expected morbidity rate per 100,000 population per annum for 85 cities for the nine weeks comprising the period of the epidemic, (B) the excess morbidity rates for this period, (C) the number of cases reported in excess of the usual or expected number, and (D) a statement as to whether the excess was in general earlier or later than, or coincident with, the outbreaks described in Sections II, III, and IV of this report.

The 85 cities are those over 50,000 population whose typhoid incidence is reported weekly in the Public Health Reports, with the addition of Pittsfield, Mass., a city reporting a marked excess in typhoid fever for the period. The rates are based on the population estimates made by the Bureau of the Census and published in the Public Health Reports, with the exception of Pittsfield, Bridgeport, Hartford, Washington, Wheeling, and Seattle, for which cities the population figures used are those of the last census. The "usual morbidity rates" are those calculated from the estimated expectancy of cases as given for each week in the Public Health Reports. This estimated expectancy for any week is the smoothed median of the corresponding weeks of as many of the nine preceding years as are reported and do not show epidemic prevalence during the period. The nine weeks on which the calculations are made are from November 17, 1924, to January 17, 1925, for cities east of the eightieth meridian, and from November 24, 1924, to January 24, 1925, for cities west of this meridian. Buffalo, Pittsburgh, Roanoke, and Charleston, S. C., are just east of the eightieth meridian and are, therefore, included in the earlier nine-week period. The cases are assigned to the week in which report was made to the Surgeon General and not to the week of onset. If fewer cases occurred during the nine weeks than the expected number, the figure indicating the difference between the actual and expected number is preceded by a minus sign. Where the expected number of cases is zero, the expected rate is given as less than one case for the total population.

TABLE NO. 37.—*Comparison of actual typhoid prevalence with expected prevalence in 85 cities of the United States during the outbreaks in New York City, Washington, and Chicago*

Cities	A Expected case rate per 100,000	B Excess case rate per 100,000	C Excess number of cases	D Time relation to Washington-Chicago outbreaks or New York City outbreak
Portland, Me	24	111	14	Earlier.
Boston, Mass	10	7	9	Coincident.
Worcester, Mass	9	0	0	
Springfield, Mass	4	4	1	Do.
Pittsfield, Mass	[1]14	390	28	Five weeks only
Fall River, Mass	24	0	−2	
Pawtucket, R. I	[1]8	0	0	
Providence, R. I	7	34	14	Earlier and later
Hartford, Conn	[1]4	0	0	
New Haven, Conn	13	10	3	Coincident.
Bridgeport, Conn	[1]4	24	6	Do.
New York, N. Y	12	67	678	Do.
Syracuse, N. Y	19	0	0	
Rochester, N. Y	11	35	19	Do.
Buffalo, N. Y	10	16	15	Do.
Newark, N. J	9	22	17	Do.
Trenton, N. J	23	0	−1	
Camden, N. J	19	0	−2	
Scranton, Pa	[1]4	74	18	Do.
Philadelphia, Pa	10	9	29	Do.
Reading, Pa	16	0	−3	
Pittsburgh, Pa	13	11	12	Do.
Wilmington, Del	35	0	−3	
Baltimore, Md	18	2	3	Do.
Washington, D. C	21	70	53	Do.
Wheeling, W. Va	31	41	4	Earlier.
Huntington, W. Va	40	0	−4	
Cleveland, Ohio	8	3	4	Coincident.
Toledo, Ohio	11	13	6	Do.
Columbus, Ohio	7	2	1	Do.
Cincinnati, O	7	39	27	Do.
Covington, Ky	[1]10	0	0	
Louisville, Ky	20	11	5	Do.
Detroit, Mich	12	11	19	Do.
Flint, Mich	15	0	−2	
Grand Rapids, Mich	12	48	12	Earlier.
Fort Wayne, Ind	6	50	8	Coincident.
South Bend, Ind	8	0	−1	
Indianapolis, Ind	7	0	−2	
Terre Haute, Ind	[1]8	0	0	
Chicago, Ill	6	22	111	Do.
Cicero, Ill	10	0	−1	
Springfield, Ill	9	19	2	Earlier.
Racine, Wis	[1]9	9	1	Coincident.
Milwaukee, Wis	6	2	2	Do.
Norfolk, Va	[1]4	0	0	
Richmond, Va	22	3	1	Earlier.
Roanoke, Va	31	42	4	Coincident.
Winston-Salem, N. C	[1]10	0	0	
Charleston, S. C	41	0	−3	
Atlanta, Ga	8	3	1	Earlier.
Savannah, Ga	39	0	−1	
Tampa, Fla	31	72	7	Later.
Nashville, Tenn	10	19	4	Earlier.
Memphis, Tenn	10	123	36	Do.
Birmingham, Ala	21	15	5	Do.
Mobile, Ala	27	27	3	Do.
New Orleans, La	17	76	53	Coincident.
Duluth, Minn	5	11	2	Later.
St. Paul, Minn	12	0	−3	

[1] Less than.

TABLE No. 37.—*Comparison of actual typhoid prevalence with expected prevalence in 85 cities of the United States during the outbreaks in New York City, Washington, and Chicago*—Continued

Cities	A Expected case rate per 100,000	B Excess case rate per 100,000	C Excess number of cases	D Time relation to Washington-Chicago outbreaks or New York City outbreak
Minneapolis, Minn	10	4	3	Coincident.
Davenport, Ia	[1] 9	9	1	Do.
Des Moines, Ia	[1] 4	0	0	
Sioux City, Ia	[1] 7	0	0	
Omaha, Neb	6	0	0	
Lincoln, Neb	10	0	0	
St. Louis, Mo	12	1	1	Coincident.
Kansas City, Mo	10	0	−3	
St. Joseph, Mo	[1] 7	0	0	
Little Rock, Ark	25	66	8	Earlier.
Wichita, Kans	15	0	−1	
Tulsa, Okla	11	0	−1	
Oklahoma, Okla	17	0	−2	
Dallas, Tex	20	0	−2	
Houston, Tex	4	0	−1	
San Antonio, Tex	3	13	4	Earlier.
Denver, Colo	4	0	−1	
Salt Lake City, Utah	14	5	1	Do.
Spokane, Wash	17	17	3	Do.
Seattle, Wash	11	2	1	Later.
Tacoma, Wash	6	0	−1	
Portland, Oreg	13	0	−2	
Sacramento, Calif	33	0	−1	
San Francisco, Calif	7	8	7	Coincident
Los Angeles, Calif	16	0	−1	

[1] Less than

Without attempting to analyze the table in this place, it may be noted that the cities with the most significant number of cases in excess (column C) coincident with the outbreaks in the three cities studied in detail, are those in the eastern and northern part of the United States, and that those in closest relation to New York City show the heaviest excess. In some cities, doubtless, the reporting of cases has been incomplete, not only for this year, but for previous years. In other cities, a high rate in previous years giving a high expectancy, may obscure a few of the cases attributable to the major causative factor in the recent epidemic. It is likely that part, if not all, of the excess in cities where the excess was considerably earlier or later than the recent outbreaks was due to factors other than the one mainly operative in the New York City, Washington, and Chicago outbreaks. For example, the health officer of Memphis states that the excess in that city was principally among negroes, and was in portions of the city presenting the poorest sanitary conditions. Taking the table as a whole, the synchronism of the excess in the cities in the Middle Atlantic and East North Central States is striking.

Besides the three cities of Washington, Chicago, and New York, where detailed studies were made, 10 other cities (Pittsfield, Provi-

dence, New Haven, Rochester, Buffalo, Scranton, Pittsburgh, Cincinnati, Detroit, and Grand Rapids) were visited. This part of the study, made from January 23 to February 11, was necessarily hurried and was only fragmentary in each city. The excess for the nine report weeks in these 10 cities was 28, 14, 3, 19, 15, 18, 12, 27, 19, and 12 cases, respectively. A brief discussion of the findings in each of these cities follows.

PITTSFIELD, MASS.

The outbreak in Pittsfield began very suddenly. All of the 28 cases occurring were reported within a period of five weeks. Thus the outbreak here was of distinctly shorter duration than those in other cities having a corresponding excess. There were only 9 cases reported within the 10 preceding months of 1924, and only 2 during the whole of 1923. In the recent outbreak, 3 cases were reported on December 8, and no cases were reported after January 7.

The social status of the persons affected was in marked contrast to that in most of the other cities studied. There were no cases among the wealthy or those associated with wealth. In practically every family more than one member were gainfully employed, and none of the individuals was in business for himself.

None of the cases gave a history of exposure to raw or undercooked oysters during the 30 days prior to onset of the disease.

The cases were in general milder than those seen in the other cities, but relapses were common.

The cases were distributed geographically with a fair degree of uniformity about the city. There was found no evidence of a common or predominant food factor, and the persons affected were not connected socially or industrially. The town is supplied with water by gravity from four watersheds without appreciable storage or treatment of the water. On account of variable pressure and a Y connection, all parts of the city were using a mixture of the four supplies. A survey of these watersheds, made by the health officer promptly at the beginning of the outbreak, showed that two of the watersheds had not been depopulated as supposed, and the water from these sources gave a rather high *B. coli* count, while that from the other two showed no colon bacilli. The two questionable sources were shut off, and no cases occurred later than 19 days after this was done.

An important factor in the sudden dangerous pollution of the water supply was a very heavy and prolonged downpour of rain on November 22. Following this there were several hundred cases of diarrhea in the city. It appears clear that the main factor in the spread of the typhoid infection in Pittsfield was water.

PROVIDENCE, R. I.

During the period of excess typhoid prevalence in Providence, which covered several weeks more, both earlier and later, than the period of excess in the cities with marked outbreaks, there were 14 cases in one group, 8 being in one family, 5 in a related family, and another, all at homes within a few doors of each other. The domestic condition in these families was said to be filthy, and the spread of the infection in this group was apparently due to "personal contact."

The excess for the nine-week period is also just 14 cases, but only 7 of the cases in this neighborhood group are assigned to the nine-week period under consideration. At least some of the remaining seven cases in excess of the normal expectancy were in persons of the class especially affected in the general epidemic.

Three cases were visited in this city. All three were in married women, apparently in affluent circumstances, each of whom had made a trip to New York during the period when the infection could have been acquired. One could not remember eating raw oysters. The other two ate "Bluepoints" on the half shell at their respective New York hotels, and at no other place did either of them eat raw oysters within the 30 days preceding onset of illness. Each of the two hotels involved was supplied at this time with oysters derived mainly from producing company A. According to oyster dealers in Providence, almost all of the shell oysters served in that city are of local origin.

NEW HAVEN, CONN.

In this city three cases in excess of the normal expectancy of four cases were reported for the nine-week period. All were among students living at Yale University. These three cases were investigated. All three of the students were of wealthy families but belonged to different academic classes and had different social relations; they did not know each other. All three had visited New York City within the period of possible infection, and two had eaten oysters on the half shell there at restaurants furnished with oysters chiefly from producing company A. The third student did not remember eating oysters on the half shell in New York City, but had eaten them in New Haven during the period of possible infection. The source of the oysters eaten in New Haven was not ascertained.

ROCHESTER, N. Y.

During the nine weeks 25 cases were reported from Rochester, an excess of 19 cases over the expectancy. The Rochester Bureau of Health has information, however, of a total of 45 cases (including imported cases) in the city within this period. This total gives an

excess of 39 cases instead of the 19 recorded in Table No. 37, and an excess rate of 71 per 100,000 population per annum.

According to statements in the city health department, of the 45 persons affected, 38 had eaten raw oysters within the period of probable infection, and in a large number of instances the restaurant involved was supplied solely with shell oysters from producing company A. Only 3 of the 45 persons affected are said to have definitely denied eating raw oysters within the 30 days before onset of illness. Practically all live in the better parts of town and most of them belong to the wealthier class.

Six cases were investigated by a representative of the Public Health Service. All of them gave a history of exposure to "Bluepoints" on the half shell. Two of these cases, one developing on November 28 and the other on December 12, were in two ladies who had a meal together at a restaurant on November 19. Each of them ate "Bluepoints" on the half shell. This restaurant's supply of oysters was obtained solely from company A.

Though the Rochester cases were rather severe, there were only 3 deaths among the 45.

Judging by the size of the oyster restaurants and the number of oyster dealers, Rochester probably consumes a large number of oysters for a city of its population. The larger local restaurants and dealers, in general, handle as their shell stock the oysters shipped by producing company A exclusively, being better satisfied with the shipping and keeping qualities of these oysters than with others which they have tried.

BUFFALO, N. Y.

Twenty-three cases here were investigated by the Public Health Service officer. In 15 of the 23 there was a history of having eaten raw oysters within the 30 days prior to onset of illness. Fifteen is the excess number of cases as given in Table No. 37. The source of the oysters was traced for nine of the cases. For all but one of them the exposure was to oysters from dealers who bought from company A. The other case was in a woman who to the best of her memory had eaten raw oysters at only one place, a club supplied solely by company F. In many of the cases the oysters were eaten out of town. The persons affected were, as a rule, in apparently good or excellent financial circumstances, many being in business for themselves or in the family of those who were thus economically independent. Geographically, the distribution of the cases was striking; the thickly populated sections of the city were little affected, the park and boulevard districts, comprising the wealthier residences, having the heaviest incidence.

SCRANTON, PA.

The outbreak in Scranton was, as in Rochester, heavy in proportion to the population. Here again the wealthier families were affected. According to the data of the health department, at least 65 per cent of the cases were in raw oyster eaters. Seven cases were investigated by the Service officer. Five of these seven cases gave a history of exposure to raw oysters. Three of the five were in persons potentially exposed to oysters supplied by company A. Three cases (including two not investigated by the Service officer) were connected with a hotel supplied with shell oysters from company A. One of these individuals was a more or less permanent guest of the hotel, one was the superintendent of one of the dining rooms, and one was the son of the proprietor.

PITTSBURGH, PA.

The records of the city health department indicate that 18 of the 26 cases reported were in persons who had eaten raw oysters within the thirty days preceding the attack of typhoid fever. The sources of the oysters to which 12 of the cases had been exposed were investigated by the Service officer. For all but one of these cases, it appeared that the oyster supply was in large part from company A, and that for 8 of these 11 cases the exposure was exclusively to oysters supplied by that company. The especial prevalence among the well to do, and in the best residential sections of the city, was noted here as in the other cities. The large dealers here also stated that the shell oysters supplied by company A are of superior grade for commercial handling, being delivered in better condition and keeping better than shipments from many other sources.

CINCINNATI, OHIO

Of 19 cases investigated by the Service officer, 11 gave a history of eating raw oysters on the half shell within the probable period of infection. Several of the remaining eight were indefinite as to exposure to such oysters, one being a fatal case in a person said to be fond of oysters, and two being in permanent residents of a hotel serving oysters only from company A. All nine of the cases in which the source of the oysters could be traced gave a history of exposure to oysters from dealers or restaurants whose stock came wholly or in part from company A. Eight of the nine cases were exposed at places where company A was the chief source of supply. This is especially significant since the largest oyster dealer in the city obtained most of his shell stock from company D. The distribution of cases in high-class residential districts and among the well to do also held in Cincinnati.

DETROIT, MICH.

In proportion to its population, Detroit is not as much of an oyster-eating city as, for example, is Rochester or Cincinnati, judging by the size and number of oyster restaurants and markets.

The excess rate of typhoid fever per 100,000 population for the nine weeks in Detroit is only 11 as compared with 39 for Cincinnati, and 35 (emended to 71) in Rochester.

In 18 cases investigated (including one suburban case), all but one person remembered eating oysters on the half shell within the 30 days preceding the onset of typhoid fever, and in all 14 where the source of the oysters eaten could be traced, that source was either certainly or potentially company A. In three other cases not seen by the Service representative, but investigated by the Detroit Department of Health, the exposure for each was reported to have been to oysters from company A. These 17 cases are within two of the total number in excess over the expected number for the period.

It is interesting that although the persons affected in Detroit included many who would be likely to patronzie clubs, and did so, in no case was there a history of having eaten oysters at the largest club in Detroit. This club buys none of its oysters from company A.

In one of the Detroit cases, oysters on the half shell were eaten on November 19 at the hotel in New York City where was held on November 18 the banquet described in Section IV (p. 77), which appeared to give rise to 10 cases in the New York district.

GRAND RAPIDS, MICH.

The excess of 12 cases for the nine-week period in Grand Rapids was contributed to by a series of 6 cases in one family living under insanitary conditions and presumably these 6 cases were due to "personal contact." Of 4 other cases investigated, one originated in Washington, D. C., one was due to local but undetermined factors, and the other 2 gave a history of eating oysters on the half shell in Chicago—one 20 days before, and the other 31 and 23 days before, definite onset of illness. All three of the Chicago restaurants involved were supplied with "Bluepoints" from company A.

DISCUSSION

(The group of 10 cities as a whole)

The Pittsfield outbreak, attributed to local water-borne infection, evidently was not a part of the epidemic under consideration. The excessive prevalence in the other 9 of this group of 10 cities seems from the evidence to have been in large degree within the main current of the epidemic.

The 82 cases investigated by Surgeon Leake composed about 40 per cent of the total, or about 60 per cent of the excess cases reported in these nine cities for the period. Of the 82 such cases, 66 were in persons who gave a history of eating raw shell oysters within the 30 days before illness. The sources of the oysters involved were ascertainable for 50 of the cases, but were not ascertainable for 16, either because the restaurant involved was out of town or for some other reason. In 48 of the 50 cases whose exposure could be traced, the exposure was either potentially or certainly to oysters from company A—that is, the oysters which the person ate were from a dealer supplied in part, if not entirely, by company A. There were in addition to these 48 cases, 38 others investigated by the local health departments, but not by the Service representative, in which the reports indicate that the exposure was potentially or certainly to oysters from company A. Thus it appears that at least 86 of the cases occurring in the nine cities were in persons exposed potentially or certainly to oysters supplied by company A. In most instances of so-called "potential" exposure, the exposure was to the supply of a restaurant or dealer furnished mainly by this company. In 36 of the 86 cases, at least one of the exposures was at a place where only company A oysters were available, and in 9 of the 82 cases investigated by the Service representative, the exposure was, according to the data obtained, to company A oysters exclusively.

The following table (No. 38) shows the oyster exposure history of the cases investigated in the 10 cities, exclusive of those in Pittsfield, Mass.

TABLE No. 38.—*Findings from investigation of typhoid fever cases in nine cities with respect to exposure to raw oysters*

	Cases investigated by representative of U. S. Public Health Service	Cases not investigated by representative of U. S. Public Health Service	Total
(*a*) Total cases reported	82	121	203
(*b*) History not obtained of eating raw oysters on the half shell during 30 days before onset	16	(1)	----------
(*c*) Raw shell oysters known to have been eaten during 30 days prior to onset	66	----------	----------
(*d*) Source of oysters not ascertainable	16	----------	----------
(*e*) Source of oysters ascertained	50	----------	----------
(*f*) Not exposed to oysters from company A	2	----------	----------
(*g*) Exposed either potentially or certainly to oysters from Company A	[2] 48	38	86
(*h*) Potentially exposed to oysters from company A	33	16	49
(*i*) Certainly exposed to oysters from company A	15	22	37
(*j*) Exposed certainly but not exclusively to oysters from company A	6	----------	----------
(*k*) Exposed exclusively to oysters from company A	9	----------	----------

[1] In cases not investigated by the representative of the U. S. Public Health Service, the differentiation was not always made between oysters served raw on the half shell and those served in other ways.
[2] 96 per cent.

The proportion of cases in which the exposure was to oysters supplied by company A is impressive (item *g* in the above table). A striking finding was that in contrast to the nine cases in which the exposure was exclusively to oysters from company A, there was only one case of exclusive exposure to oysters from any other source.

In most of the 66 cases in persons exposed to raw oysters, the person did not remember positively the kind of oysters ordered from the menu and eaten; but for all of the 27 cases in persons remembering this positively, it was stated that the kind eaten was "Bluepoints."

Of 15 cases in which the exposure was to only one source of oysters, that source was company A, certainly in 9, and probably in 5 of the other 6.

CONCLUSION

The main factor in the spread of the infection causing the excessive prevalence of typhoid fever in this group of 10 cities, within the 10 weeks ending January 10, 1925, was raw shell oysters supplied by company A; and in 3 of the 10 cities, other factors, including especially water and personal contact, operated to a considerable extent.

Section VI

GENERAL DISCUSSION AND CONCLUSIONS

The preceding sections of this report indicate that the studies were sufficiently comprehensive and intensive to ascertain all the facts necessary to form a basis for definite conclusions. The data obtained in any one of the situations which were studied intensively are impressive; and when those obtained from all the situations are considered together, the evidence appears entirely conclusive.

At the outset of the intensive studies in each of the three cities—New York, Chicago, and Washington—every factor regarded as *possibly* having been operative in the spread of the infection which had caused the outbreak of typhoid fever in that city was set down and was given careful consideration. Included in the list of possible factors were (*a*) city water supply, (*b*) bottled waters, (*c*) milk and cream, (*d*) ice cream, (*e*) butter, (*f*) cheese, (*g*) marketed bread and pastry, (*h*) local (home) insanitary conditions, (*i*) association with typhoid patients, convalescents, or carriers, (*j*) uncooked vegetables, and (*k*) uncooked shellfish. None of such factors was eliminated until the evidence made the further consideration of it as one of practical importance untenable.

The general features of the outbreaks suggested from the outset a major causative factor common to the situations in all three cities. As the studies went on, the reports of findings in the three cities were brought together and compared; and what at first was regarded as a suggestion of a common major factor became later on a strong probability and finally a practical certainty.

Although the findings in any one of the situations were such as to eliminate most of the hypothetical factors, a comparison of the findings in the several separate cities furnished important contributory evidence upon which to base a conclusion as to the major causative factor or factors in the outbreak in each city and in the outbreaks, or excessive prevalence, in the whole group of cities involved in the epidemic.

The discussion which follows, though dealing with some things, or conditions, which might have operated as a major causative factor locally in any of the cities, is devoted mainly to those which might have operated as a major causative factor in all of the cities at the same time.

DISCUSSION

City water supplies.—The city water supply of one of the cities could not have been a considerable factor in the spread of the infection in the other cities. In Pittsfield, Mass., the city water supply appeared the major factor, and in Washington, D. C., a small part of the public water supply distributed in a limited and defined section of the system of water mains was, according to the evidence, a comparatively small vector of the infection causing the outbreak in that city. There is no evidence that the public water supply of any of the other cities in which our studies were made played an appreciable part in the spread of the infection causing the epidemic.

Bottled waters.—The small proportion of cases of typhoid fever among persons using bottled water of any kind either habitually or occasionally eliminates bottled water as an appreciable factor.

Milk and milk products.—Any supply of milk or cream which might have operated importantly as a vector of infection in one city was not distributed to the other cities involved. Most of such supplies are pasteurized. There was no undue proportion of cases of typhoid fever chargeable to any of the milk, cream, ice cream, buttermilk, butter, or cheese supplies of any of the 13 cities. According to the statements obtained, every butter supply distributed to any two or more of the cities involved was made from pasteurized cream. The small proportion of the cases of typhoid fever furnished by children, the general features of the outbreaks, and the specific findings from the studies, definitely eliminate milk and other dairy products as a considerable factor.

Bread and pastry.—On general principles, bread or pastry would not be expected to operate importantly in the causation of outbreaks such as those under consideration. Most of the supplies which conceivably might have been involved were limited in distribution to the city, or the immediate vicinity thereof, in which they were cooked. The outputs from bakeries reaching more than one large city are, as a rule, prepared for and handled in the wholesale trade in a way to exclude heavy contamination with typhoid-infection matter. There was no evidence of an undue proportion of cases chargeable to any supply of bread or pastry in any of the cities.

Local insanitary conditions.—The outbreaks fell especially upon persons living under the best sanitary and economic conditions of modern city life.

Personal contact infection.—Only a very small proportion of the cases (less than 5 per cent of those investigated) were in persons who gave a history of immediate association with typhoid fever patients or convalescents or with known typhoid bacillus carriers. Evidently personal contact infection was only a minor factor in the epidemic.

Bacillus carriers at public eating places.—As a large proportion of the cases of typhoid fever was in persons who patronized restaurants and since "carrier" infection offers a very elastic and convenient hypothesis for one who prefers hypothesizing to working for facts, it is natural that some interested observers of the recent epidemic have suggested—in some of the instances with a show of serious reflection—that the outbreaks may have been caused by infection spread by typhoid bacillus-carriers among workers (waiters, cooks, bus boys, or others) engaged at restaurants. It is not conceivable that one in possession of the salient facts in the situation can hold reasonably to the hypothesis that bacillus carriers among persons at restaurants were the spreaders of the infection causing the outbreaks. An army of bacillus carriers would have been necessary to fulfill the conditions. Many restaurants in a number of different cities were involved at the same time. The period of causation of the outbreaks was less than seven weeks in duration. The outbreaks were somewhat explosive in character. They began suddenly and they terminated rather abruptly without any adequate, far-reaching measures having been carried out to remove human "carriers" from the public eating places. For human "carriers" in restaurants to have spread the infection causing the recent typhoid epidemic, they, themselves, would have had to occur on or about November 1, 1924, as an explosive epidemic of an unusual carrier state attended with violent diarrhoeic or diabetic attacks, or both, and exceeding dirtiness of personal habits; and about six weeks later, they quite suddenly (due to the advent of the season of hibernation or for some other reason) would have had to cease to operate.

Though a human "carrier" in a restaurant here or there may have spread the infection causing a case or two of typhoid fever developing within the period of the epidemic, there is not a single point of evidence suggesting even remotely that typhoid-bacillus "carriers" among persons working at restaurants were more than a very minor factor in the spread of the infection within the period of causation of the epidemic.

Raw vegetables.—The proportion of cases furnished by persons exposed to uncooked vegetables other than lettuce or celery was too small to be of significance. The proportion of the cases in persons giving a history of exposure to lettuce or celery, or both, was large; but it was found that the proportion of the general population exposed to lettuce and celery within the period of causation of the outbreak was also large (see Tables Nos. 4, 24, and 36). The proportion so exposed among those who contracted typhoid fever was no larger than that among the scores of thousands of persons of comparable economic status who escaped the disease, though living

in the same neighborhood and in many instances patronizing the same restaurants as the persons who were stricken. The comparatively low incidence of typhoid fever within the periods of the outbreaks in the three cities among children of the wealthier class and among persons in all age groups in the less well to do classes is significant when considered in connection with the now common use of lettuce and celery as food by our city people. Due to complexities of the marketing, it was found practically impossible to trace back to their sources the lettuce or celery eaten by the average individual within a stated period of 30 days.

As the evidence pointed strongly to public restaurants rather than to the homes as the place of ingestion of the infection in the three cities visited by the definite outbreaks, a painstaking and successful effort was made in one of these cities (Chicago) to trace back to the original shippers the lettuce and celery served at four of the large popular restaurants which appeared clearly to be involved in the distribution of the infection (see pp. 46 to 48).

The possibility of infection in lettuce or celery had to be recognized in view of the extensive and widely separated producing areas and the lack, remarkable as it may seem, of official sanitary supervision approaching adequacy in many of the rural districts comprising the areas in which this important food production industry is conducted.

In order to determine if lettuce or celery from any of the producing areas could have conveyed infection to all of the cities involved in the epidemic, an effort was made to get a line on the shipments consumed in Chicago, Ill., New York City, and Washington, D. C., within the period of causation of the epidemic. The Bureau of Agricultural Economics in the United States Department of Agriculture furnished data with respect to interstate shipments from which are compiled the figures used in the following tables (Nos. 39 and 40).

TABLE NO. 39.—*A summary of the lettuce deliveries in car lots to the Chicago, New York, and Washington, D. C., markets from October 27 to November 15, 1924*

[Data supplied by the U. S. Department of Agriculture]

City	State in which lettuce was produced													
	California	Colorado	Idaho	Oregon	Minnesota	New Jersey	New Mexico	New York	Utah	Virginia	Washington	Wisconsin	Wyoming	Unknown
Chicago	122	1	56	10	1	0	2	0	2	0	1	0	1	0
New York	117	0	6	4	0	315	3	17	0	8	0	0	0	0
Washington	5	0	0	0	0	0	0	1	0	0	0	0	0	1

TABLE No. 40.—*A summary of the celery deliveries in car lots to the Chicago, New York, and Washington, D. C., markets from October 27 to November 15, 1924*

[Data supplied by the U. S. Department of Agriculture]

City	State in which celery was produced					
	Illinois	California	Michigan	New Jersey	New York	Unknown
Chicago	(1)	6	39	0	10	0
New York	0	0	0	6	160	0
Washington	0	1	0	0	17	1

[1] Unknown amount.

The period of consumption of the car lots of vegetables enumerated in these tables corresponds to the major part of the period of causation of the outbreaks. When these figures are carefully studied, the improbability of lettuce or celery from any of the main producing areas having been the major vector of the infection in Chicago, Washington, and New York City, becomes apparent. It is evident that only California lettuce or New York celery might have operated. In a report dated January 19, 1925, from Senior Surg. J. C. Perry, it is stated that the lettuce from the Imperial Valley of California appeared, on his then recent survey of that situation, to be grown and packed in a sanitary manner. Chicago received more California lettuce than New York City and, yet, had less than one-sixth as many cases of typhoid fever. Many cities to which California lettuce was distributed, appeared to escape an excessive prevalence of typhoid fever in this period. Chicago, receiving 10 car lots of New York celery while Washington was receiving 17, had over twice as many cases of typhoid fever. New York City, receiving 16 times as much New York celery as Chicago, had less than eight times as many cases of typhoid fever.

Such analyses of the figures in Tables Nos. 39 and 40 do not eliminate celery or lettuce, because, if infected batches from any of the large producing areas had been introduced into the large shipments from time to time, they might have had a very freakish distribution; but the results of such analyses are in harmony with the many other points of evidence which lead away from the incrimination of either of these vegetables.

If our findings had implicated no other possible factor any more nearly than they did lettuce or celery, it would be utterly impossible for us to reach a conclusion as to the factor or factors involved in the spread of the infection causing the epidemic. Where no evidence was found to implicate lettuce or celery, however, very convincing evidence was found to implicate another possible factor.

Raw shellfish.—The small proportion of cases among persons giving a history of eating raw clams eliminates this shellfish as an important factor.

Raw oysters, however, appear in a very different light. Of the total of 452 cases furnishing definite histories with respect to the eating of raw oysters in the 13 cities visited, 349, or 77.2 per cent, were in persons exposed to the eating of raw oysters within 30 days immediately before definite onset of typhoid fever. This fact alone is highly significant because the proportion exceeds tremendously the proportion of the general population of any of these cities composed of persons who ate raw oysters in the corresponding period (see Tables Nos. 4, 24, and 36).

In the vast majority of the cases, the raw oysters eaten were from the shell.

A strikingly large proportion of the oyster eaters who developed typhoid fever had ingested, within the 30-day period before illness, small ("Bluepoint") raw shell oysters which were traced to shipments from a producing company operating within the vicinity of West Sayville, N. Y. This company is designated in the several sections of this report as "company A." Persons exposed either exclusively or potentially to raw shell oysters distributed by company A, composing in Washington less than 1 per cent and in Chicago less than 1.5 per cent of the population, furnished, respectively, over 58 per cent and 82.5 per cent of the cases of typhoid fever contracted in those cities within the period of the epidemic (see pp. 27 to 29, and pp. 52 and 53). Of the cases investigated in nine of the other cities visited, 81.3 per cent of those giving definite histories with respect to oyster eating were furnished by persons who were exposed exclusively, certainly or potentially, to company A's oysters (see pp. 89 and 90). Even in the mazes of the distribution of shell oysters in New York City (see pp. 69 to 77), the lines led back to company A's supply in a very impressive manner. The evidence implicated no supply of raw oysters consumed within the period of causation of the epidemic except those of company A and company F (see pp. 76 and 80). The operating plants of these two companies are adjacent to each other, as is shown in diagram No. 7.

The proportion of cases occurring in the outbreaks giving a history of exposure to company F oysters was comparatively small. It is stated by officials of company A that that company frequently bought shell oysters (mainly small-sized ones) from company F and two or three other companies in that vicinity in October, November, and December, 1924. Therefore, the infected oysters shipped by company A may have come originally from the supply of company F or some other source. If such was the case, however, company F must have disposed of most of its infected oysters through its sales to company A.

Raw shell oysters were distributed during the period of causation of the epidemic by company A direct to all three of the cities—Wash-

ington, Chicago, and New York—visited by the definite outbreaks, to 6 of the 10 cities which had a markedly excessive prevalence, and to 7 of the 11 cities which had a slightly excessive prevalence of typhoid

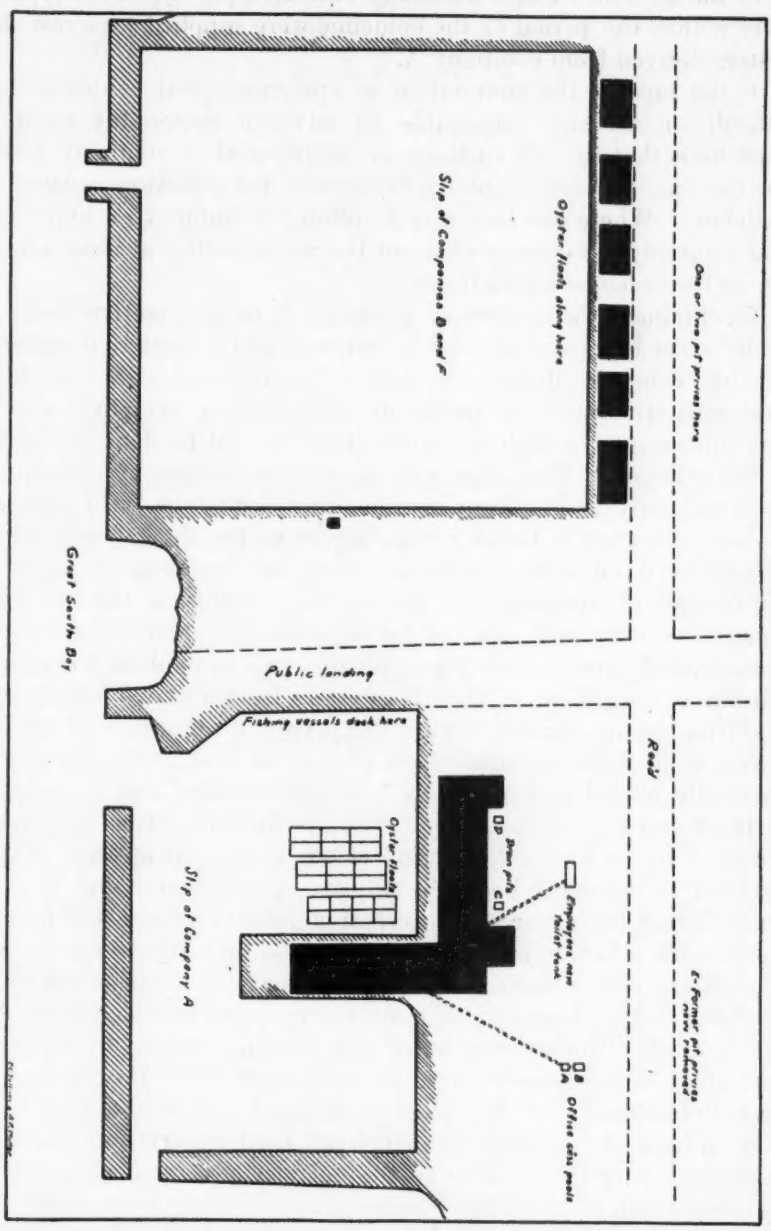


DIAGRAM No. 7.—Showing operating plant of company A and vicinity

fever enumerated in Table No. 1 (pp. 6 to 9). Of the four cities with markedly excessive prevalence but not supplied direct by company A, three are in the vicinity of New York City and some of the

cases occurring in these cities certainly were in persons exposed, while away from home, to company A oysters.

Of the 85 cities enumerated in Table No. 37 (pp. 82 and 83), at least 19 of the 26 which had a definitely excessive prevalence of typhoid fever within the period of the epidemic were supplied with raw shell oysters derived from company A.

In the face of the summation of epidemiological evidence, it is difficult or actually impossible to advance reasonably even an hypothesis that the raw shell oysters distributed by company A were not the major factor in the conveyance of the infection causing the epidemic. Where one fact may be offered to support an hypothesis that company A's oysters were not the major factor, at least a dozen are on the scene to knock it out.

To eliminate the oysters of company A as a causative factor, it would seem necessary at least to prove that the oysters distributed by that company during the period of causation of the epidemic were entirely free from pollution with human excreta, either in concentration or in high dilution. This can not be done in the face of the evidence. The sources of the oysters bought by company A from company F and from several other companies or dredgers or jobbers operating in Great South Bay or within the general vicinity thereof have not been ascertained by us nor, so far as we know, by the officials of company A. The sanitary quality of the oysters so bought was not and can not be determined. The bacteriological examinations made after the epidemic was recognized were made too late to furnish proof that the oysters from a stated supply were free from contamination during the period of causation of the epidemic, even if the so-called "low scores" arrived at by the present seemingly liberal and obviously complex standard can be accepted as proof one way or the other. From such information as could be obtained by us within the period of our studies, it appears that all parts of the growing beds of company A in Great South Bay are quite distant from sources of excretal pollution on shore and that the chances for infection of the oysters in those beds by sewage from off shore were very remote. Boats of various kinds (including oyster dredging boats), however, plied over the waters in which those beds are located. The equipment of the dredging boats of company A and of other companies operating in Great South Bay during the period of causation of the epidemic included open toilets so that the excreta from the dredgers on such boats went directly into the water over the oyster beds. Due to the delayed advent of cold weather in the autumn of 1924, the oysters in the beds of Great South Bay, or that general vicinity, probably did not reach an advanced stage of hibernation before November 15 or 20. Thus, it appears that those oysters were "drinking" freely in the period involved, and

it is at least conceivable that an oyster here and there in those beds became infected from the excreta of the dredgers or of other persons on boats plying in those waters.

At the plant of company A, a certain proportion of the oysters delivered at the wharf but not needed for shipments on the day of arrival were stored in floats alongside the wharf. The water over the oysters in the floats had a depth, it is said, of only 2 or 3 feet as a rule. Dredging boats lay alongside the wharf a considerable portion of the time. A number of fishermen engaged in the scalefish industry tied up their boats at night at a wharf only about 20 yards across the slip from the floats of company A. Visitors could have gone to the wharf of company A at night. Some of the night watchmen or the day workers on the wharf or some of the visitors to the wharf or some of the fishermen frequenting the immediate vicinity of company A's wharf or some of the oyster dredgers may have been temporary or habitual typhoid-infection carriers. It is hardly conceivable that some persons did not void their excreta into the water, especially at night, at points near-by the floats of company A. Thus, the possibility of infection of oysters in the floats must be recognized. From the surveys made in January, 1925, by Public Health Service officers, no evidence was obtained of pollution of the water over company A's floats by sewage from the toilets on shore within the vicinity of the wharf, but it is possible that some one of these toilets was in some unusual and undiscovered condition at times in October and November which was not apparent in January.

The reports of the New York State Health Department indicate that typhoid fever was prevalent on Long Island and especially in the town of Islip, in which West Sayville is located, in October and November, 1924. Health News (Vol. 1, No. 43, p. 172) of October 27, 1924, states under the heading of "Typhoid Fever," "To date 14 cases have been reported in connection with the Central Islip State Hospital epidemic." Health News (Vol. 1, No. 49, p. 196) of December 8, 1924, states, under comment on typhoid fever cases reported from November 24, 1924, to November 29, 1924, the following: "An investigation is being made of an outbreak in Sayville, Islip, Bay Shore, and Brightwaters, Suffolk County. Eight cases have thus far been reported. The outbreak, in all probability, is water-borne."

With such a number of typhoid fever patients, the probability of the existence of some temporary "carriers" within the general vicinity of West Sayville in October and November, 1924, must be recognized.

Two cases of typhoid fever developed, one in October and the other in November, among oyster dredgers living in Greenport, L. I.

Observers, both official and unofficial, state that the oyster beds and the plant of company A have been for years regarded as being from a sanitary standpoint among the very best in the industry. This company has had sanitary chemical toilets installed on its dredging boats since the middle of December, and has manifested a definite desire to carry out any and all sanitary measures necessary to safeguard further its products against infection. A sanitarian viewing the matter in the abstract might feel that it would have been more nearly in keeping with the fitness of things for the infection in oysters to have been traceable to the supply of some of the producers much less attentive to sanitary measures than is company A.

The sanitary surveys found nothing, however, to tend to negative the epidemiological findings implicating the oysters distributed by company A as the major causative factor in the spread of the infection causing the epidemic.

Thus, the chain of evidence appears complete and conclusive.

CONCLUSIONS

1. The main factor in the spread of the infection causing the recent excessive prevalence of typhoid fever in New York City, Chicago, Ill., Washington, D. C., and several other cities in the United States, was beyond reasonable doubt, shell oysters distributed by a producing company operating within the vicinity of West Sayville, N. Y.

2. The preponderance of evidence is that the general supply of no large distributor of oysters was uniformly infected, but that oysters infected in one or more beds or part or parts of one or more beds or at one or more floats, and constituting but a small proportion of the total, were introduced into and distributed with a large supply of oysters of good sanitary quality.

3. The period of causation of the markedly excessive prevalence was between October 25 and December 20, 1924, and there is no reason to believe that oysters distributed since December 20, 1924, by the company referred to in conclusion 1, or any other large distributor, have been to date (March 12, 1925) any more of a factor in the spread of typhoid infection than such oysters were in any corresponding period within the last several years.

4. The evidence is that due to temperature changes in some bed or beds or part or parts thereof; to discontinuance of receipts from the infected source or sources; or to sanitary measures which have been carried out by the oyster producers within the vicinity of their floats and on their dredging boats, or to a combination of such factors of safety, oysters on the market since December 20, 1924, have been free from any considerable degree of typhoid infection

and that those now being sold or offered for sale are, from a sanitary standpoint, as safe to eat as raw food as is usual at this season of the year.[1]

5. There is no evidence that shellfish other than oysters or that scalefish contributed to the spread of the infection causing the recent excessive prevalence of typhoid fever, and there is no reasonable cause for any popular apprehension that shellfish or scalefish which are heated throughout to a temperature of 100° C. before being eaten are not now as safe and salutary for human consumption as usual.[1]

6. In the interests both of our public health and of our food industries, measures should be applied promptly for more nearly adequate official sanitary supervision, regulation, and protection of industries engaged in the production, preparation for sale, and distribution in traffic, of shellfish, vegetables, fruits, milk, milk products, and other foods eaten usually or frequently without being cooked.

7. The principles of action embodied in resolutions adopted at a conference of the United States Public Health Service, Bureau of Chemistry, Bureau of Fisheries, with State and municipal health authorities, State conservation commissions and representatives of the shellfish industry held in Washington, D. C., on February 19, 1925, should, if properly applied, do much, both to safeguard the public health and to restore public confidence in the safety of uncooked oysters as food.

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[1] This statement is as of Feb. 10, 1925, and Mar. 12, 1925.

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APPENDIX

Resolutions Adopted as a Basis for Permanent Oyster Control by the Conference on Shellfish Pollution, Washington, D. C., February 19, 1925

1. The beds on which shellfish are grown must be determined, inspected, and controlled by some official State agency and the United States Public Health Service.

2. The plants in which shellfish are shucked or otherwise prepared or packed by the shipper must be inspected and controlled by some official State agency and the United States Public Health Service.

3. The freedom from typhoid bacilli of the workers who handle shellfish must be determined by some official governmental agency.

4. Failing to secure sufficiently high standards to protect the people as regards beds, floating and plumping practices, and methods of shucking or other methods of preparation, a satisfactory practical method of pasteurization or other heat treatment, or chemical, or biological method which produces satisfactory results, must be installed and operated under proper governmental supervision.

5. There must be such governmental supervision and such trade organization as will make plain the source of shellfish and will prevent shellfish from one source being substituted for those from another source. This will be chiefly a problem of the individual State.

6. The methods of shipping must be supervised, inspected, controlled, and approved by the proper official Federal and interstate agency.

7. The methods of storing, displaying for sale, and dispensing must be determined, inspected, and controlled by the proper State or city agency.

8. The product must conform to an established bacterial standard and must meet Federal, State, and local laws and regulations relative to salinity, water content, food proportion, and conform to the pure food laws standards.

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